TELE-TECH

Formerly the TELE-communications TECH-nical Section of

ELECTRONIC INDUSTRIES

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Help FM Live Up to Its Reputation

In these months of 1947 FM stations are spreading across the country at a gratifying rate. FM broadcasters, are daily, yes hourly, laying the foundation on which FM will stand in the future. Millions of radio listeners, who have been told of the added listening pleasure that will be theirs if they get one of the new FM receivers, expect much. They expect noise-free reception, background silence and high-fidelity reproduction. If these attributes of FM broadcasting are not conspicuously evident when the prospective receiver customer listens for the first few times, his disappointment is going to react disadvantageously for the future of FM development.

Every FM engineer should see to it that every FM transmitter and receiver installation measures up to the full possibilities of this matchless new broadcasting service.

Apartment-house TV Antennas

Some New York landlords have banned the use of roof-top antennas for television—and loosed a storm of protest from energetic president Jack Poppele of Television Broadcasters Association, finally resulting in submission of a proposal for temporary settlement.

The original real-estate mens' action, as Poppele points out was unfair to tenants, and was analogous to the situation which existed when radio began to become popular enough to make of every apartment house roof a forest of antennas. Anyway, the landlords don't want any more individual antennas and have so stated in no uncertain terms. Meantime, work is progressing on the development of master antenna systems though no plan has yet been proposed covering the important matter of payment for such equipment, or its use. Nevertheless, many TV set owners will continue to see pictures, as many of them are now seeing them, with a dipole in the room or out the window. And as the power of TV broadcasters is increased, perhaps the antenna problem won't be as important as it now seems.

Technical "Friends of the Court"

The radio electronic art is largely based on patents. There are many cases of patent litigation constantly in our courts,—yet how many learned judges sit in these courts who know a transformer from a rheostat? In many instances their decisions must be based on nothing more scientific than whether they like the cut of the defending lawyer's coat or the appellant's smile!

Either special patent courts should be established, or judges should appoint qualified technical advisors, who would handle the technical testimony and help the court arrive at its decision.

Radio for Fire Control

The startling extent to which new arts become integrated into our complex civilization is illustrated by the use of radio in the field of operations of the Bureau of Land Management, Department of the Interior. In this government branch 215 radios, mostly portable, are used for fire control to maintain contact with lookouts and with fire bosses on going fires. Another use is in grazing districts to contact remote crews. Frequencies used are 2264, 2558, 2926 kc and also 38,020 and 36,220 kc. Probably the departmental employes are wondering how they ever got along without these vital aids.

IT IS THE BUSINESS OF THE ENGINEER — to find ways and means for preserving and in fact advancing the prosperity of our country and of our people. Prosperity comes not from subsidies, wage and price increases, bonuses and unemployment relief. Prosperity comes only from production.

The foundation for the maintenance of a high standard of living is a high level of productivity. A high level of productivity must rest upon a firm foundation of engineering. There is nothing new in this statement. It is as fundamental as any law of nature. — Dr. W. R. G. Baker, President IRE.

Portable

By LEONARD MAUTNER, Project Engineer, TV Studio Facilities Section, Allen B. DuMont Laboratories, Passaic, N. J.

Fig. 2—Control equipment for a dual camera chain set-up as used for a field pick up

• Because so many new wartime-developed circuit technics are available to complement the existing information on portable television gear [1] [2] [3] [4] a complete reexamination of the problem was undertaken to permit introduction of simplified operation.

In describing the resulting camera chain, it will be of interest to analyze the choice of circuits and components.

The first choice was necessarily that of the pickup tube. The decision to use a type 2P23 Image-orthicon, even with a compromise in signal-to-noise ratio and maximum resolution, was more than justifiable in view of the tremendous gain in sensitivity and lack of shading obtainable, with the wide range of lighting conditions prevalent in field use. In other tubes low sensitivity, shading problems, mosaic charging or ion spot difficulties appeared to make them basically inferior for this purpose.

Practical considerations were next in importance, and these dictated the methods of packaging the equipment in a large measure. The camera was to be as small and light as possible to obtain maximum maneuverability, and the camera controls were to be kept as simple as possible. To obviate parallax troubles, an electronic viewfinder seemed desirable, and to avoid the problem of high impedance power supplies and to make for convenient use of differentials in camera cable lengths, a camera auxiliary relatively close to the camera proper was indicated. It was visualized that a central control point for video operations would permit the use of a minimum number of operating personnel, consequently the critical electrical operating controls were advantageously placed in camera control units, to be centrally located with the channel switching equipment and the synchronizing generator.

Finally, flexibility for multiple chain use was an important factor; since it was felt that a four camera chain could easily cope with the most exacting demands of program directors. The basic single camera chain consists of only five units; a double camera chain consists of eleven units, and additional chains add but four units per chain to the double camera chain assembly.

To reduce the weight and size, miniature tubes were used whereever possible. The use of subminiatures was not considered practical, particularly since the dissipation requirements for tubes in video applications are relatively high. The recommendations of the RMA Eng. Dept., particularly those of the Subcommittee on Television Studio Facilities, were given particular attention.

Single Camera Operation

To provide for single camera chain operation, it was found necessary to make provisions for the addition of synchronizing signals in two alternative positions. When a single chain is used, blanking and synchronizing signals are added to the picture information in the camera control and monitor unit, whose output is then of standard form. When multiple operation is called for, only blanking is added in the camera control units, and the several such picture signals are then sent to the mixer amplifier and monitor unit, where the desired

[1] G. L. Beers, O. H. Schade, and R. E. Shelby, "The RCA Portable Television Pickup Equipment"; Proc. I.R.E., V. 28 P. 450, Oct., 1940.

[2] M. A. Trainer, "Orthicon Portable Television Equipment"; Proc. I.R.E., V. 30 P. 15, Jan., 1942.

[3] R. L. Campbell, R. E. Kessler, R. E. Rutherford and K. V. Lansberg, "Mobile Television Equipment"; Proc. I.R.E., V. 30 P. 1, Jan., 1942.

[4] W. A. Howard, "Portable Video Pickup Equipment"; Electronics, V. 19 No. 8 P. 124, Aug., 1946.

Camera Chain for Field Use

Technical details of new circuits, design arrangements and equipment using Image-orthicons, widely adaptable, expandable to fit conditions

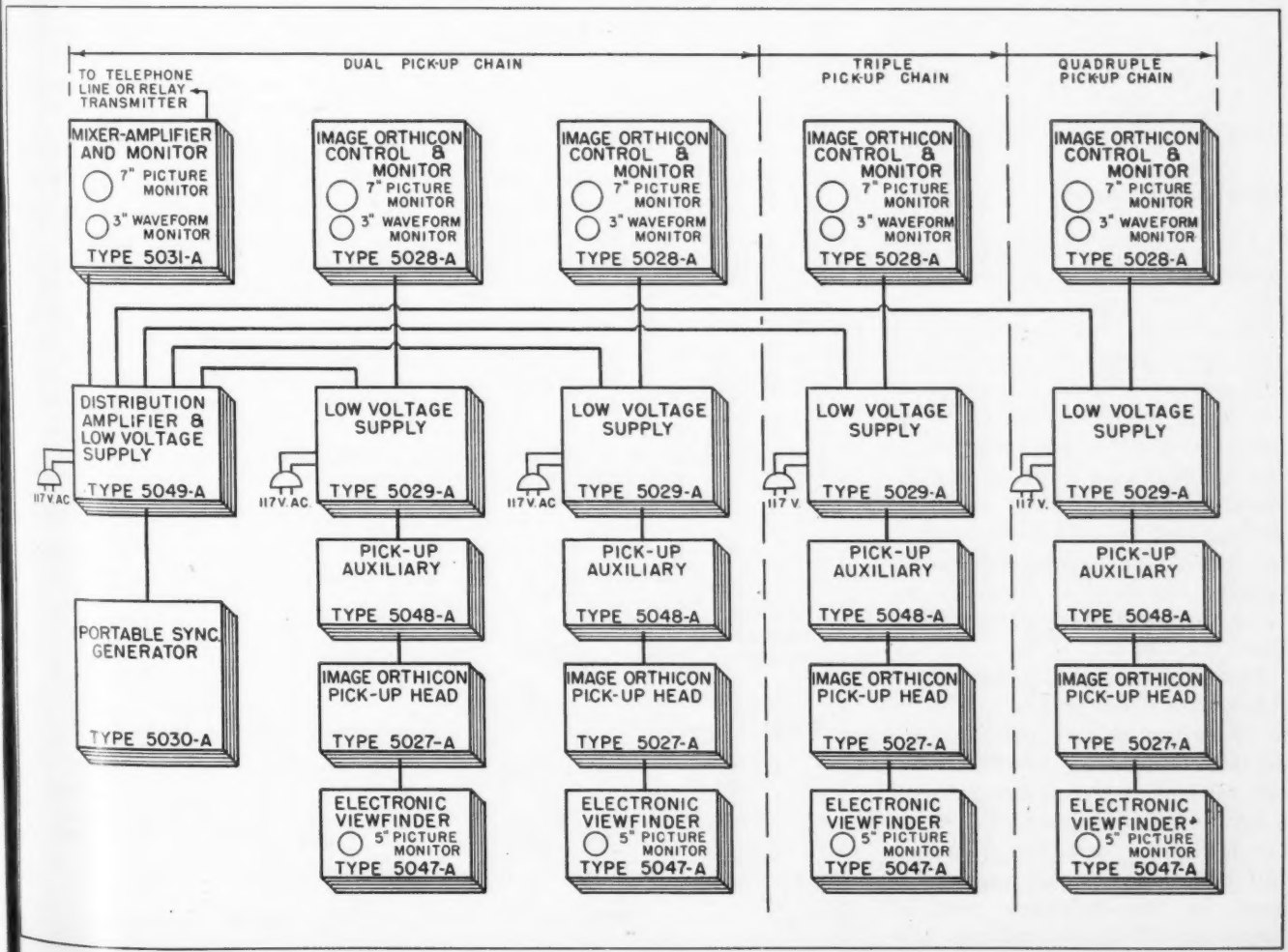
video signal or combination of signals is selected and mixed with synchronizing pulses. The resultant electrical information then comprises the output video signal.

The complete control equipment complement for a dual camera chain is shown in Fig. 1. The camera and electronic viewfinder are housed in one combination unit, suitable for mounting directly on a tripod or dolly base, Fig. 3. The camera contains a type 2P23 Image-orthicon, and the associated circuits: video preamplifier, blanking multivibrator, and horizontal and vertical deflection circuits.

For the six stage preamplifier the type 6AK5 offered the highest figure of merit for video amplification purposes. A voltage feedback video amplifier was employed, which requires no peaking adjustment for normal operation, thus simplifying initial set-up. The gain-bandwidth product and transient response of the amplifier is comparable to that obtained with shunt peaking. Six stages of gain allows a sufficient reserve for video equalization of long cable lengths, when required. A remote control of the amplifier gain is available at the camera control unit.

In the peaking circuit, Fig. 4, it

Fig. 1—Block diagram showing how basic units can be assembled to provide pick-up service up to a four-camera chain. For a simple chain five units are required



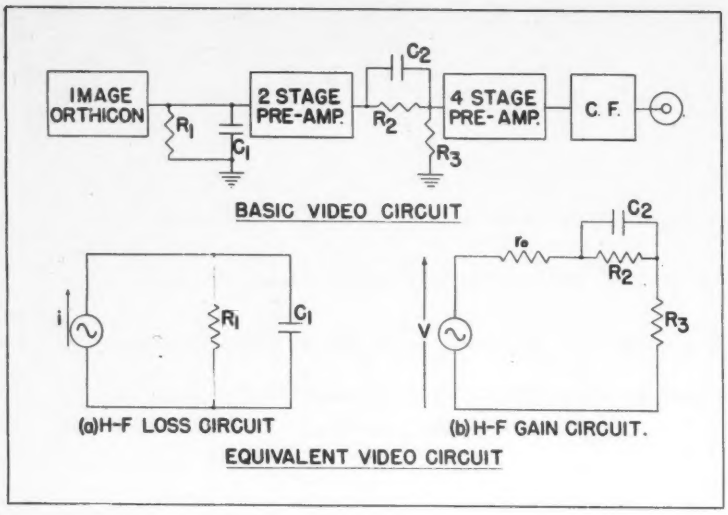


Fig. 4 — Video circuit arrangement with high frequency peaking circuit connections

can be shown that if $R_1C_1 = R_2C_2$, then a substantially flat frequency response (limited only by the frequency response of intervening amplifiers) is obtained, eventually falling off 3 db at f_0 where

$$f_c = \frac{1}{2\pi C_2(R_3+r_0)}$$

where r_0 is the equivalent internal resistance of the constant voltage generator representing the video amplifier driving the peaking network. If R_3 is shunted by an appreciable capacitance, it may be necessary to shunt-peak R_3 so as to make it appear resistive for the desired frequency range.

Blanking Methods

Local camera blanking is supplied by the blanking multivibrators in the camera. It is not possible to blank the control grid on the Image-orthicon because this will provide a white signal during blanking. By returning the target potential to a negative voltage during the blanking interval, the retrace lines are removed from the picture and the signal corresponds to "black" during blanking. Local camera blanking is normally set to be narrower than the final RMA blanking width.

Deflection circuits for the Image-orthicon are essentially the same as those for 50° magnetically deflected cathode-ray tubes. An 807 (or 6BG4) as sweep driver, with a type 6AS7G damper tube serve for horizontal deflection, while a full 6J6, transformer coupled, is used in the ordinary vertical sweep circuit. A powered iron core horizontal deflection transformer provides sufficient voltage overshoot to provide the +1500 volts for the Image-orthicon electron multiplier, using a type 8016 high voltage rectifier. The filament supply for the latter is also furnished by deflection power.

Separate horizontal and vertical driving pulses are supplied to the camera on 75-ohm coaxial lines, and a nominal 1.0 volt peak-to-peak black negative signal is returned by the camera from a 6J6 cathode follower.

The electronic viewfinder is arranged to show the camera picture signal directly on a 5-in type 5FP4 cathode-ray tube. This tube provides excellent focus and furnishes the cameraman with a useful viewfinder. Since the local camera blanking is narrower than the final picture blanking the viewfinder monitor shows a slightly greater field of view than the final picture.

A type 6AS6, a wartime-developed coincidence tube, is used to amplify the camera output video level for presentation on the 5FP4, to provide additional blanking for the viewfinder monitor, by suppressor grid insertion. The deflection circuits for the picture tube are similar to those used for the Image-orthicon itself. The 5-kv supply is obtained by rectification of the horizontal overshoot voltage from the deflection circuit.

Pan handles, to provide for easy manipulation of the camera, have rotatable knurled sections on the right controlling optical focus, and on the left for changing the iris opening of the lens. Thus the

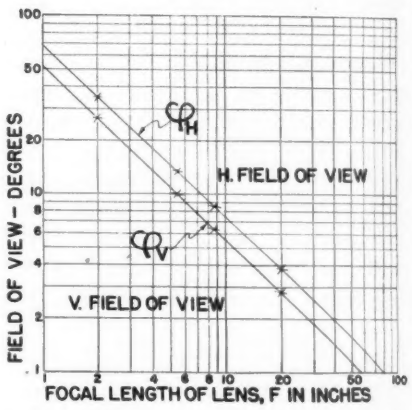


Fig. 5—Angular field of view, compared with focal length of lens in inches

cameraman can vary these two parameters without losing control of the camera, a desirable feature in televising action scenes.

A four lens turret is mounted on the front of the camera. Since the mosaic size of the 2P23 is fixed, it is possible to compute the angular field of view, both hori-

Fig. 6—Adjustable multivibrator circuit as provided in the camera auxiliary unit

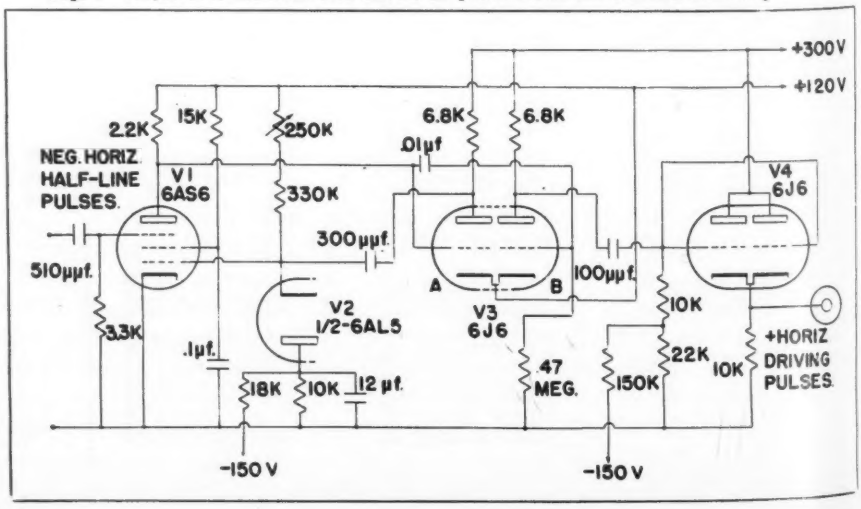


Fig. 3—Image-orthicon camera and viewfinder head

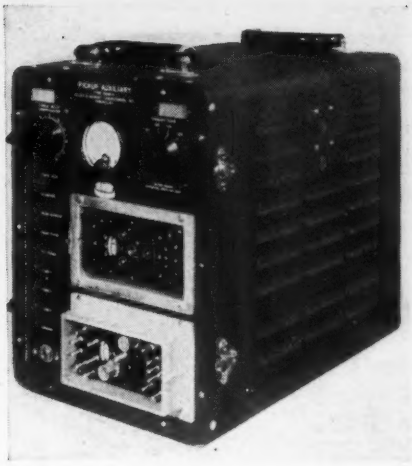


Fig. 7—The camera pick-up auxiliary

Fig. 8—Camera control and monitor unit

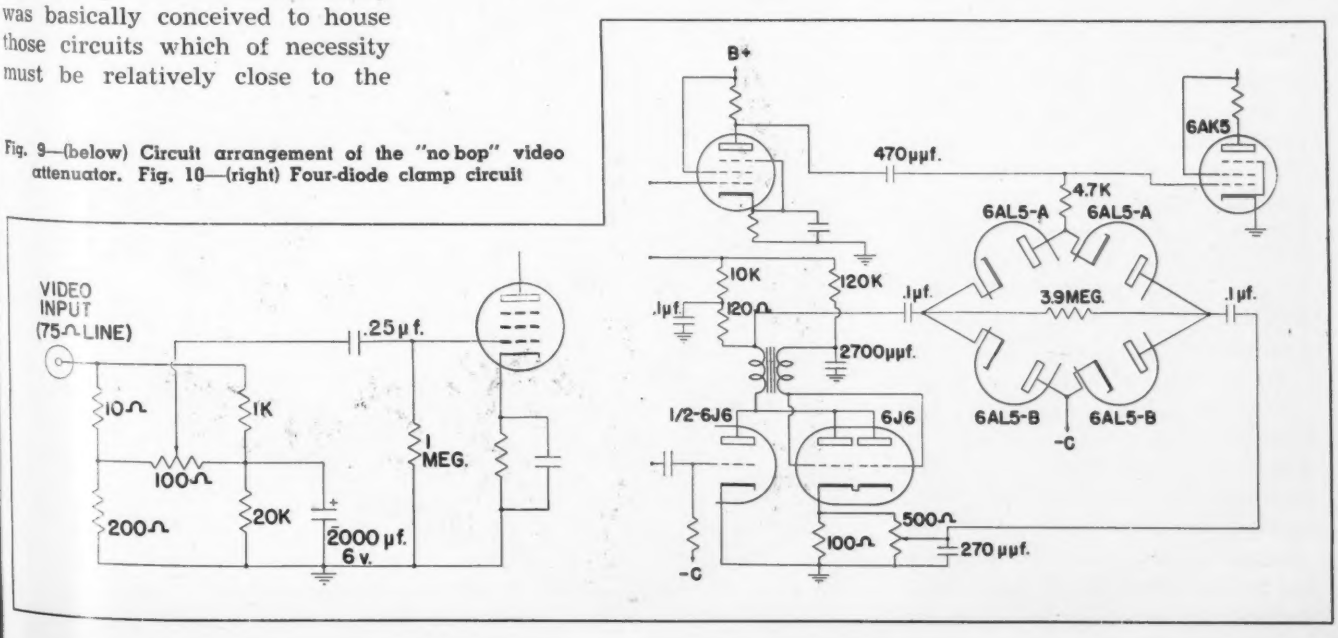
zontal and vertical readily for any given focal length lens. In the graph of the angular field of view for different focal length lenses, Fig. 5, the starred points show specific lenses that are often used in field work. Lenses longer than 20 in. in focal length, while providing tremendous magnification, have such a small field of view as to require extreme stability of camera mounting and careful aiming. In general, such extremely long focal length lenses are useful only in exceptional circumstances.

The camera auxiliary, Fig. 7, serves as a connecting link between the camera and the camera control unit. It is normally situated in proximity to the camera, within about 30 ft. so as to allow some freedom in camera location without moving this unit. The auxiliary was basically conceived to house those circuits which of necessity must be relatively close to the camera, but which can be packaged separate from the camera, so as to keep the latter equipment as small as possible. The camera auxiliary provides (1) separation circuits for the horizontal and vertical driving pulses; (2) regulators for the dc power supplies which furnish power to the camera proper; (3) delay the horizontal driving pulse to take account of delays in long camera cables; (4) focus coil current regulation for the Image-orthicon.

To minimize the number of coaxial conductors in long camera cables, it was found expedient to supply mixed horizontal and vertical driving pulses from the synchronizing generator for the long cable run to the auxiliary, and to separate the pulses in that unit, providing separate horizontal and vertical driving pulses to the camera. Of the available methods of pulse separation, such as by amplitude, width, or pulse coding, it was felt that width separation was most economical and stable. The horizontal driving pulses are about one microsecond in width, while those at vertical rate are about 25 microseconds in width, measured at 50% points. The usual straightforward RC integration and differentiation circuits effectively serve to separate these pulses which are sent on coaxial lines to the camera.

The vertical pulses are derived directly from the cathode circuit of a blocking oscillator, while the horizontals are specially treated to give the desired delay. The problem of equalizing the delay in transmission path over long cables

Fig. 9—(below) Circuit arrangement of the "no bop" video attenuator. Fig. 10—(right) Four-diode clamp circuit



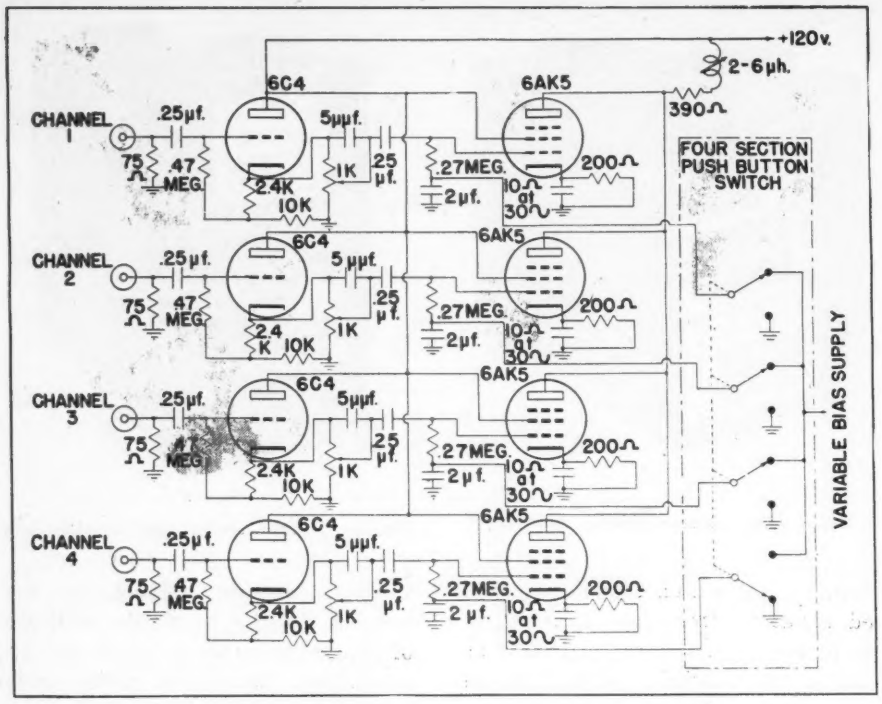


Fig. 12—Four-channel automatic electronic mixer circuit

for the horizontal driving pulse in a four camera chain is not simple. To provide simple delay lines in the unit which distributes horizontal driving pulses to all cameras is a straightforward but not particularly neat solution; it complicates the synchronizing distribution equipment, and does not provide continuous delay adjustment to accommodate odd cable lengths.

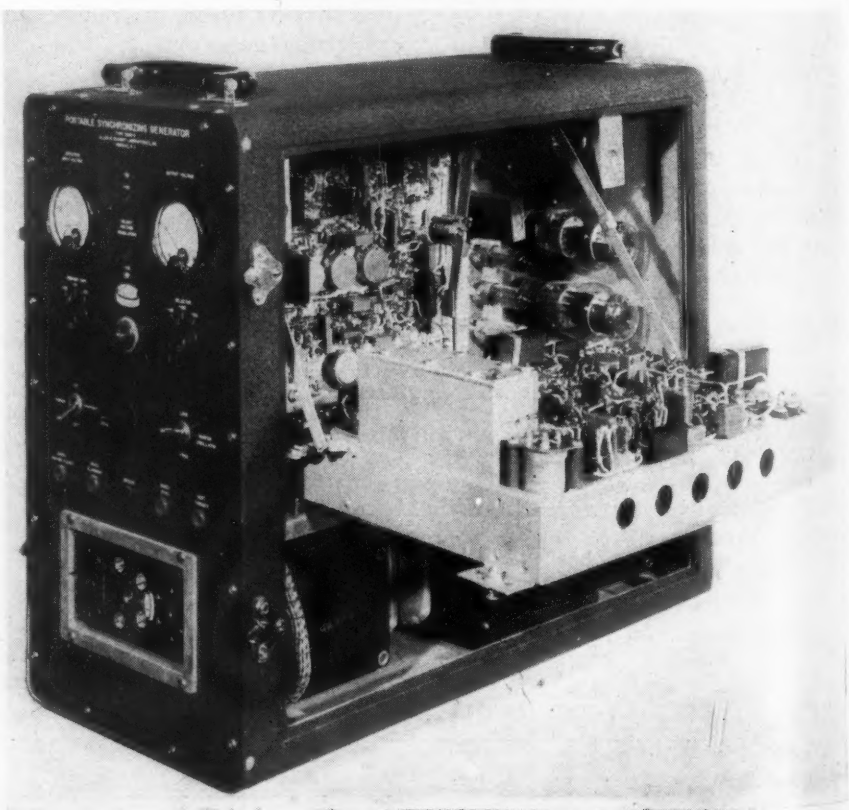
Delay Compensation

Since cable lengths of up to 1000 ft. may sometimes be required, the round trip delay may be of the order of 3 microseconds, assuming the velocity of propagation of pulses in a cable to be only 60% of that in free space. It would be indeed convenient if an "anticipator circuit" for horizontal driving pulses could be placed in the camera auxiliary for the furthest camera, so that its video information would arrive no later than that from a nearby camera. Since this is not practical, an alternative was chosen.

As the horizontal driving pulses are formed in the synchronizing generator, they are arranged to occur at a time midway between horizontal synchronizing pulses; this is a time phase normally thought of as proper for equalizing pulses. When these "half- line" driving pulses are received at the camera auxiliary unit, they are delayed an amount equal to a half line less the cable delay to be compensated for. Thus a multivibrator delay circuit, whose delay is continuously adjustable between about 25 and 32 microseconds, is used for this purpose in the camera auxiliary unit. The net result is effectively the loss of one active line compared to an undelayed system. The stability requirements for such a delay multivibrator are stringent, with a short term uncertainty of less than a picture element. This requirement is met with the circuit illustrated in Fig. 6.

Negative pulses on the suppressor grid of V_1, cut off its plate current. This tube is the normally "on" section of a triggered multivibrator. As the plate of V_1 rises it raises the grid of V_{3a}, the normally "off" section of the multivibrator. By regeneration, V_1 is cut "off" and V_{3a} is turned "on". The negative excursion of the grid V_1 is limited by the diode V_2; this tends to stabilize the delay time of the multivibrator for changes in characteristics of V_{3a}. The delay time is then primarily determined by the time constant in the control grid circuit of V_1. The rear edge of the resultant gate on the plate of V_1 is amplified and selected by the cathode follower, V_4. A positive pulse which can precede the actual synchronizing pulses by as much as 5 microseconds is then sent via coaxial cable from the

Fig. 17—View showing internal construction of the portable generator which gives a complete standard RMA sync signal



cathode of V_4 to the camera unit.

The focus coil for the Image-orthicon must be held constant because so many parameters depend on this condition being maintained. An 807 beam power pentode is connected in series with the focus coil and the +300 dc supply; the focus coil current is then conveniently adjusted to a constant value by varying the cathode bias on this tube. Due to changes in ambient temperature the resistance and hence the focus coil current would vary if this stabilizing means were not employed.

Unregulated positive dc supply voltages of +425 and +260 volts

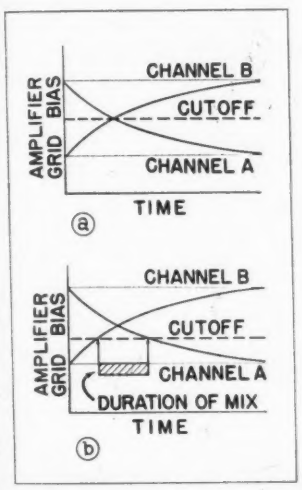


Fig. 13—Bias conditions for automatic mixer shown above in Fig. 12

are supplied to the camera auxiliary unit by the low voltage supply situated near the camera control unit, and these are regulated and reduced to +300 and +120 volts, respectively, for use in the camera circuits. The +120 volt supply must be particularly free from ripple and quite stable, to assure proper operation of the video preamplifier in the camera. While two regulated supplies have often been used in cascade to serve this purpose, in this case it was held more economical of circuit components and space to use a high gain 3-stage regulating amplifier to achieve the requisite stability and low ripple.[5]

The inherent internal resistance of such a supply is less than 0.05 ohms, and its residual 120 cps ripple is less than about 1 millivolt, RMS.

[5] L. Mautner, "Design Considerations for Voltage Regulated Power Supplies"; Electrical Engineering (forthcoming).

Fib. 11—Mixer amplifier and monitor unit. Fig. 14—Low voltage supply unit. Fig. 15—Distribution amp. and LV supply. Fig. 16—Portable synchronizing generator

The camera control and monitor unit, used at the control and operating position for one or more camera chains, is pictured in Fig. 8. Through the use of recessed thumb wheel controls for all except the video and pedestal adjustments, it is possible to keep the front panel relatively neat in appearance; this would be difficult to achieve if regular knobs had been employed in view of the many controls required.

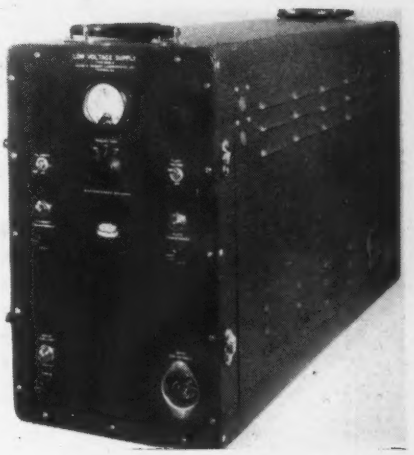
Camera Control and Monitor

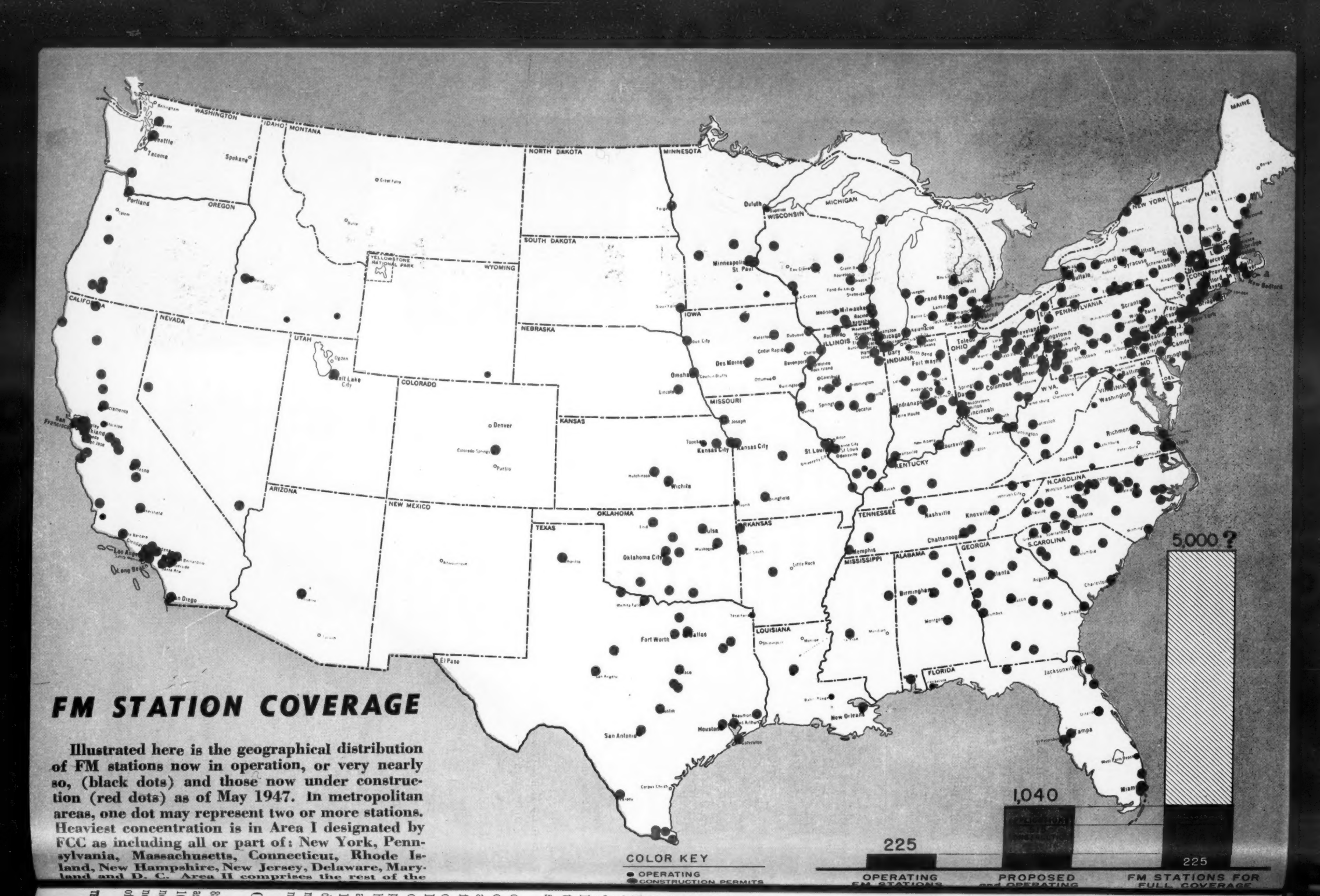
The unit itself consists of the following basic sections: a video picture monitor type 7BP4 cathode ray tube; a video waveform monitor type 3JP1 cathode ray tube; Image-orthicon electrical operating controls (remote adjustments of camera tube potentials) and a video amplifier with line-to-line clamping, blanking and (optional) sync insertion facilities.

The video picture monitor, of conventional design, consists of a video amplifier suitable for grid modulation of the picture tube, plus the associated deflection circuits. Centering current for the deflection yoke is derived from a separate low-voltage high-current supply, with a selenium rectifier. A type 6AS6 pentode in the video amplifier provides a convenient video gain or contrast control, by varying its suppressor voltage.

The video waveform monitor in the equipment permits examination of the camera output signal at either line or field rate for shading, signal level and stability purposes. The 3 in. cathode-ray tube operates at about +3 kv, derived from the +5 kv sweep flyback supply of the video monitor deflection circuit. It gives a very bright display capable of being interpreted even under conditions of high ambient light since this tube was originally designed for air-

(*Continued on page* 100)





FM STATION COVERAGE

Illustrated here is the geographical distribution of FM stations now in operation, or very nearly so, (black dots) and those now under construction (red dots) as of May 1947. In metropolitan areas, one dot may represent two or more stations. Heaviest concentration is in Area I designated by FCC as including all or part of: New York, Pennsylvania, Massachusetts, Connecticut, Rhode Island, New Hampshire, New Jersey, Delaware, Maryland and D. C. Area II comprises the rest of the

FM Rapidly Spreads Over the US

Nearly 300 transmitters operating, 300 CPs and 500 applications pending indicate substantial progress — Receivers total 600,000

• The map illustrates the disposition of FM stations now on the air and those soon scheduled for operation. First point you will notice, of course, is the natural move to cover U. S. population, not U. S. geographical area, even more critical than for AM broadcasting.

For the purpose of frequency allocation, the U. S. is divided into two FM areas—Area I and Area II. Area I includes all of Connecticut, Rhode Island, Massachusetts, New Jersey, Delaware and the District of Columbia; Maryland, as far West as Hagerstown; Eastern Pennsylvania, as far West as Harrisburg; Southeastern New York, as far North as Albany—Troy—Schenectady; and Southern New Hampshire. Area II includes that part of the United States not specified in Area I.

Current FCC allocation plans for class B FM stations allows most channels to the state of Texas with a total of 101 frequencies. California and New York are next in order with 96 and 89 respectively. Delaware is low on the list with only 3. In city allocations, Metropolitan New York and Los Angeles have 20 channels each. Chicago and San Francisco are next with 19 and 18 respectively. The black dots on the map signify stations now on the air; the red ones, those now under construction.

Channel Allocations

Twenty channels in the new 88-108 mc FM band are designated as class A channels. These run from 104.1 mc through 107.9 mc (channels 281 through 300). These channels are available for cities outside of metropolitan areas, except for those metropolitan areas which have fewer than 6 class B channels. For class B stations, 60 channels running from 92.1 mc through 103.9 mc (channels 221 through 280)are designated.

Class A stations will be licensed primarily to serve centers of population outside of metropolitan areas, and are referred to as community stations. Transmitter power ratings for these class A stations are from 250 to 1,000 watts, but the stations shall normally be capable of a coverage equivalent to a minimum of 100 watts or a maximum of 1,000 watts of effective radiated power. Coverage is based on a 1,000 microvolt contour for the central urban population and a 50 microvolt contour at the limit of the area served.

Service Areas

Class B stations are licensed to operate with a service area equivalent to a maximum of 20 kw effective radiated power and an antenna height of 500 ft. above average terrain. In Area I, minimum coverage for class B stations is that equivalent to 10 kw effective radiated power and an antenna height of 300 ft. above average terrain. In Area II, minimum coverage for class B stations will be equivalent to 2 kw of effective radiated power and an antenna height of 300 ft. above average terrain. In Area II, however, class B stations will be encouraged to use greater power and greater antenna heights where such grants would not interfere with other duly authorized stations.

The term "antenna height above average terrain" differs for the two classes of stations. For class A stations this term means the height of the antenna above the average elevation of a circle of the terrain 10 miles from the antenna. For class B stations this term means the height of the antenna above the terrain 2 to 10 miles from the antenna. Average elevations of radials to a distance of 10 miles from the antenna are themselves averaged to determine the "antenna height above average terrain".

Field Intensities

Median field intensity requirements are 1,000 microvolts per meter for city, business or factory areas; 50 microvolts per meter for rural areas. Evidence of FM coverage beyond theoretical calculations tends to refute the "horizon is the limit" rule; that two horizons is nearer to actual practical coverage results.

At the present writing, some form of realignment of frequencies for FM stations serving the same area appears certain as FCC recently concluded tests on alternate channel operation and found evidences of cross-talk. Several alternate plans are reported to have been drafted, but all are based on a common rule that stations serving the same area will have at least three or four channel separation—preferably more.

Anent FM progress, a brief recapitulation will show how the picture is changing. In May of 1940 the FCC issued a press release "hailing frequency modulation as one of the most significant contributions to radio in recent years.

(*Continued on page* 120)

FM Receiver Front-End Design

By C. R. MINER, Section Engineer, Receiver Division, Electronics Dept., General Electric Co., Bridgeport, Conn.

Elimination of variable capacitors through substitution of a unique variable inductor in GE's "guillotine" tuner, solves tuning problems

• Adequate treatment of FM "front-end" design involves a great many practical, as well as theoretical, considerations. Also, many points of controversy are encountered in establishing what constitutes acceptable FM performance.

The front end of a receiver includes all of the tuning elements, radio frequency and converter circuits, tubes, bandswitch, etc., preceding the IF system. The number and types of tubes, the types of circuits and the number of tuned circuits are factors which vary considerably from one design to another depending on the price class of the receiver and the judgment of the engineer as to what constitutes acceptable performance. The design considered here is that of a better class receiver which might retail at prices from $250 upward in the form of a console radio-phonograph combination. Emphasis has been placed, therefore, on performance and quality rather than on price alone while still maintaining high dollar value to the consumer.

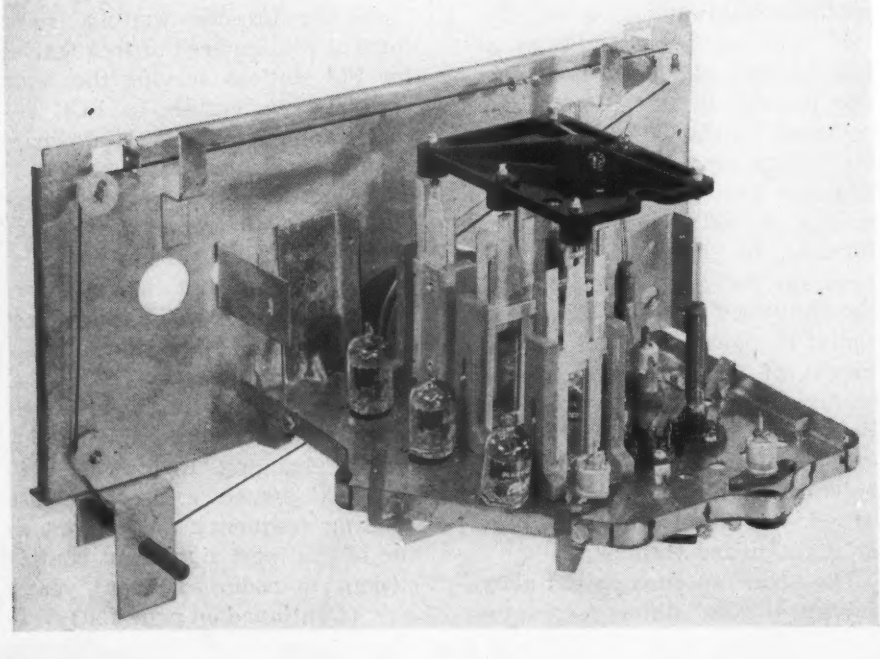
If one were to list the problems of a front end design, he might place them in this order of importance: (1) tuning elements; (2) tubes; (3) circuitry; (4) mechanical assembly or manufacturability.

All these problems have been made especially difficult by the assignment of the 88 to 108mc band to FM, the underlying difficulty being the task of combining in one front end assembly, tuning elements, tubes, and circuitry in a manufacturable mechanical layout suitable for operation at such widely separated frequencies as one megacycle and 100 megacycles. This assumes, of course, that any commercial FM receiver must also provide reception in the standard broadcast AM band. In addition, in any better class receiver, coverage of one or more short wave AM bands is required and in the design to be discussed the old FM band of 42 to 50 mc is covered as well.

In deciding upon the type of tuning elements to be used, it immediately becomes apparent that variable capacitors are probably least desirable for tuning the 100 mc band. A gang capacitor for use at these frequencies should preferably have an insulated rotor shaft in each section in order to avoid common coupling between tuned circuits if maximum performance is to be obtained. In addition, the rotor contact resistance is troublesome at these high frequencies which suggests the use of split stator and double rotor arrangements.

While a receiver perhaps can be designed without these special features in a gang condenser, the design, nevertheless, would be troublesome in production or compromises in performance must be accepted. Then, in addition, a gang condenser is a bulky component which does not readily lend itself to good mechanical layout which

Completely assembled front end built around the "guillotine" tuner, showing plastic "elevator" which raises and lowers the blades



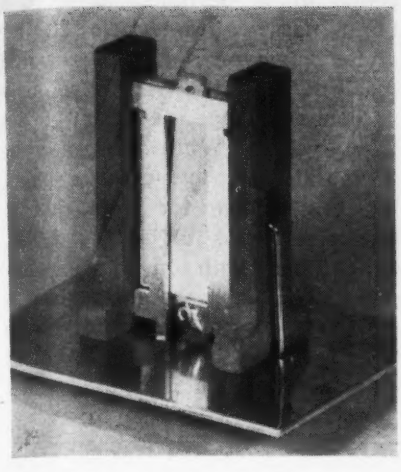


Fig. 1—Close-up of variable inductance tuner, styled "guillotine" because of its resemblance to that French instrument

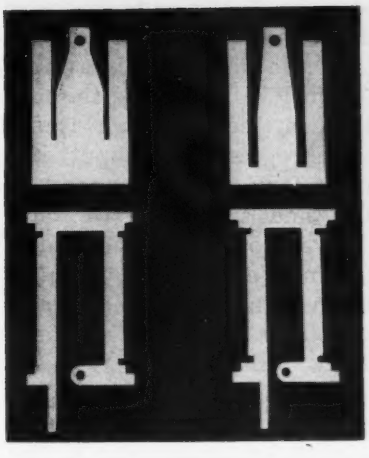


Fig. 2—An rf and an oscillator frame and corresponding blades. Oscillator frame is narrower to provide lower inductance

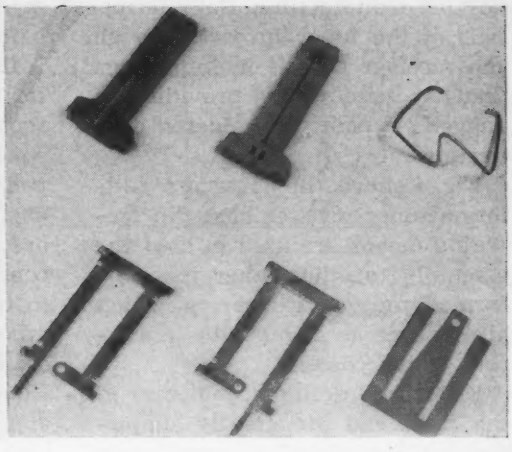


Fig. 4—Unassembled parts of "guillotine" tuner. Music wire spring, serving as mount, is only fastening means

will permit short enough leads for high frequency use. Every engineer is familiar with the microphonic tendencies of gang condensers.

The alternative to gang condenser tuning is some form of variable inductance tuning. Permeability tuning has been used successfully and appears to offer a good solution to the tuning problem. However, there is difficulty in winding the coil with sufficiently uniform pitch in production to maintain satisfactory calibration and tracking. The difficulty arises because the coils have so few turns and because of the need for using a large wire size to maintain a high Q.

A permeability-tuned coil has been developed which uses a special braided tinsel for the winding, affording greater ease of winding and improved tuning range as well as Q. However, very close control of the winding pitch still is required. Other difficulties, such as the handling of winding terminations, mounting and wiring problems and the necessity for very thin wall coil forms, lead one to seek other means of tuning a 100mc receiver.

Fig. 1 shows a type of variable inductance tuner which has been found to satisfy the requirements of tuning at these frequencies most satisfactorily. This tuner consists of two identical brass frames which, when connected at their open ends, form a two-turn inductance. The inductance of the two turns is varied by insertion of a brass blade between the frames. The effect of the blade is only to reduce the inductance of each frame and the mutual inductance between them. Capacity effects of the blade are negligible, since the blade has no electrical connection to the circuit.

Tuning Curve Adjustment

The tuning curve is adjusted by cutting slots in the blade which provide an easy and permanent means of tracking the oscillator and rf circuits with each other. In Fig. 2 is shown an rf and an oscillator frame and corresponding blades. Note that the oscillator frame is narrower to provide the required lower inductance to tune the oscillator 10.7 mc above the signal frequency. The oscillator blade has larger slots to provide the reduced tuning range necessary for perfect tracking. The narrower width of the oscillator frame also is of value in reducing the effects of parallel sideways movement of the blade due to clearance in the guide grooves.

Fig. 3 shows the tuning curve of the tuner which is nearly linear. Also shown is the variation in Q of an rf tuner. This variation is of no real consequence, since the minimum value is sufficiently high so that the circuit Q is controlled by other factors, such as tube loading and losses in tube sockets and bandswitch.

Because of its physical resemblance, this type of slide tuner has acquired the name "guillotine tuner". It is used to tune both old and new FM bands and two or more short wave spread bands in General Electric FM receivers.

This type of tuner has the great advantage of being entirely tool made, the human element being absent except for the soldering operation in connecting the two frames together electrically. Very precise production control of tracking is, therefore, possible without high labor content in the

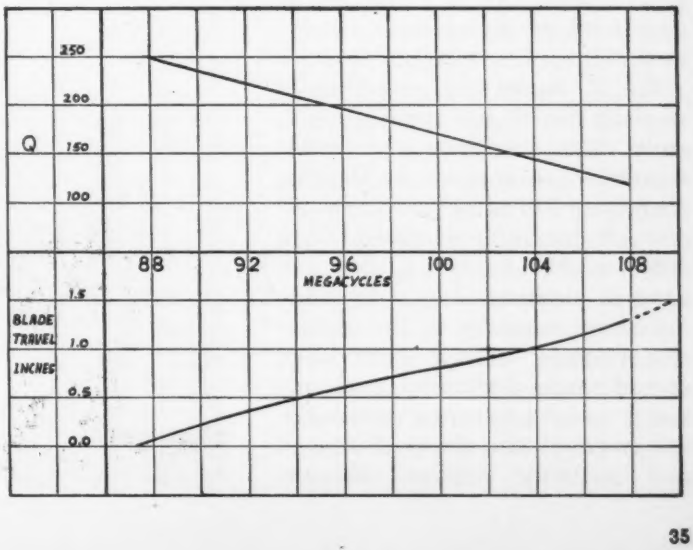


Fig. 3 — Upper curve shows variation in Q of an rf tuner; lower curve shows that tuning is essential linear

cost of manufacture. Both terminals of the tuner project through the receiver chassis making short leads possible and providing a rugged tie point for soldered connections.

Fig. 4 shows the parts of a guillotine tuner unassembled. No fastening means are used to hold the assembly together other than the formed music wire spring which also serves to mount the guillotine to the chassis.

Electrical design problems in the front end are greatly simplified by the use of the guillotine tuner, since it is possible to localize each tank circuit within a small area and to keep rf chassis currents at a minimum. Microphonic troubles are almost completely absent and since the blade of the guillotine is ungrounded, sliding contacts and pigtails are not required. All of these factors contribute to obtain an efficient electrical design which has high performance with little trouble from regeneration or alignment difficulty.

Orthodox Circuits

The circuits used with the guillotine tuner are no different from those required for permeability tuning. Two typical antenna stage arrangements are shown in Fig. 5. Circuit A has the advantage that the capacity values involved are fairly large and less trouble is experienced from stray capacities than in circuit B. However, it is convenient to feed the center tap of the guillotine as shown in Fig. 6 in which case the coupling capacitor may be four times as large as when feeding at the top. No great difficulty is experienced then with excessive stray capacities.

Fig. 7 shows the arrangement used in the rf and oscillator circuits. For simplicity the circuit complications imposed by the low frequency FM band and the various AM bands are omitted. Coverage of the low frequency FM band is obtained simply by adding shunt capacity to the guillotine circuits. In the short wave spread bands, additional shunt capacity as well as series inductance are switched into the guillotine rf and oscillator circuits. In this manner the 19-, 25- and 31-meter bands are covered separately.

In the selection of the best tubes for use in FM front ends, the first requirement besides high transconductance, is high input impedance. Low inter-electrode capacities and small physical size are also important. High transconductance obviously is needed to obtain high gain in the rf and mixer stages and for sufficient oscillator strength at 100 mc. However, high transconductance alone is not sufficient without high input impedance, for if the tube presents a serious load across the tuned circuit, low gain and selectivity will result. One must, therefore, compare tubes on the basis of a figure of merit which takes into account both of these factors. In the case of an rf tube, this figure is: $Gm\sqrt{Ri}$.

This neglects consideration of grid-to-plate capacity which, of course, must be taken into account in establishing the maximum stable gain per stage.

Such tube types as the 6BA6 or 6AG5 generally are acceptable for use as the rf tube except that some trouble is experienced because of low input impedance. This is not serious if the input circuit is untuned or is designed to have a band pass characteristic 20 mc wide. However, such tubes would load the guillotine tuner seriously and poor image rejection ratios would result. While this may be permissible in low-price designs, the best choice for high quality receivers seems to be the 6AK5, which has both high transconductance and high input impedance. The input impedance of this tube is greater than 10,000 ohms at 100 mc which is 3 to 5 times that of other high Gm tubes.

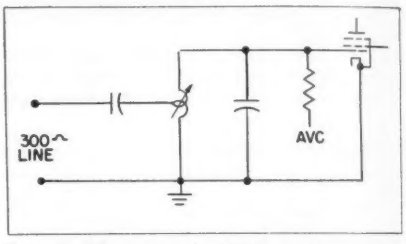
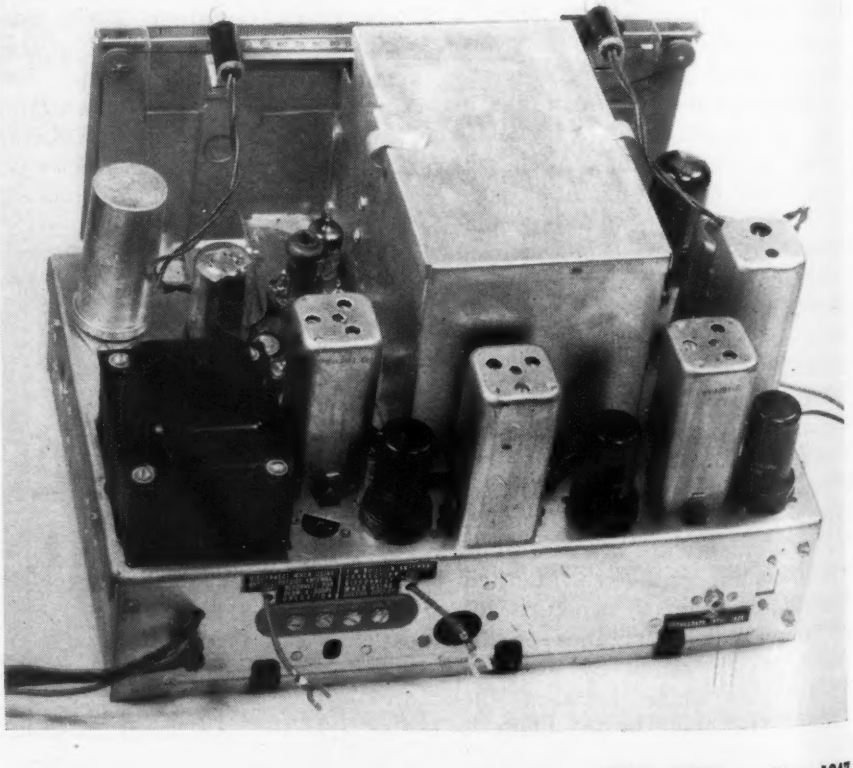


Fig. 6—Manner in which center tap of tuner may be fed to eliminate stray capacities

For converter use, the 6SB7-Y is used in several designs. However, it has been necessary to operate the oscillator at half frequency because of inability of the oscillator section of this tube to sustain stable oscillation in the 100 mc region. Also, this tube has the defect of large size and re-

Fig. 8—In completed form the tuner assembly is enclosed in a metal box for shielding, mechanical protection and dustproofing. Receiver is a 10-tube model



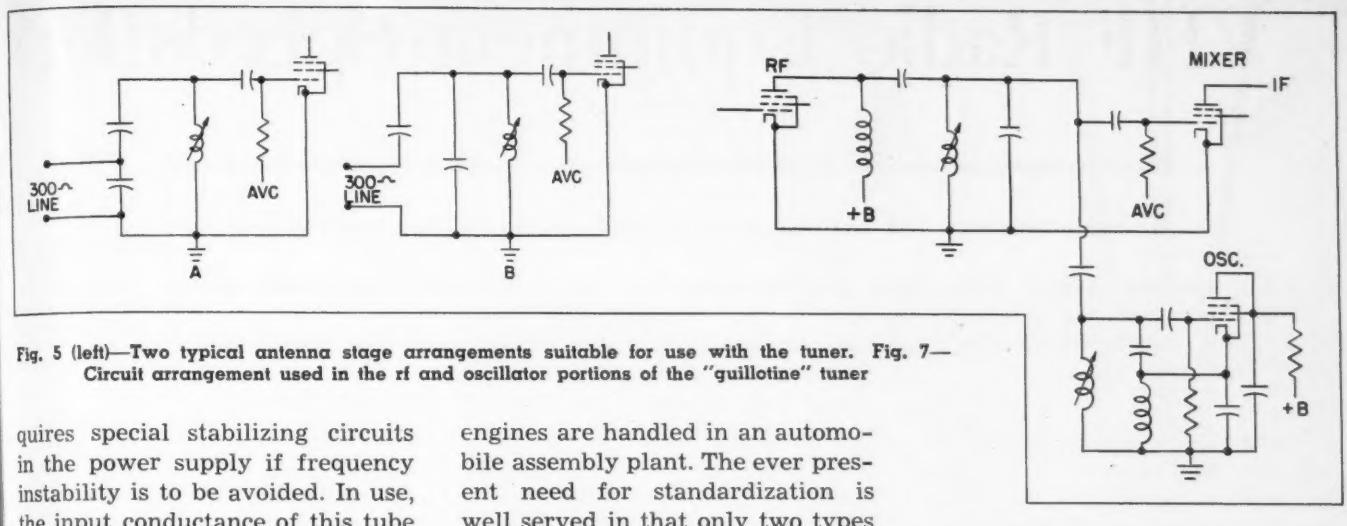


Fig. 5 (left)—Two typical antenna stage arrangements suitable for use with the tuner. Fig. 7—Circuit arrangement used in the rf and oscillator portions of the "guillotine" tuner

quires special stabilizing circuits in the power supply if frequency instability is to be avoided. In use, the input conductance of this tube is negative due to large amounts of oscillator voltage appearing on the control grid. This is a help insofar as loading of the input circuit is concerned, but gives rise to alignment and stability problems which are difficult to handle in production, even if neutralizing circuits are provided.

These considerations dictated the use of separate mixer and oscillator tubes in the receiver. The 6AK5 is used as a mixer tube with a separate 6AK5 as the oscillator. An alternative selection for the oscillator might have been the 6C4 but it was found that in the short wave AM bands, because of circuit problems, sufficient oscillator strength could not be obtained.

On page 34 is a photograph of a unit front end assembly using the guillotine tuner. The blades of the guillotines are raised and lowered by a plastic elevator which is driven by a windlass. The assembly also includes the broadcast band tuning elements which are driven by the same means.

The design of this front end assembly as a separate unit anticipates that production assembly and testing will be localized in a department set apart from the main chassis production line. This has the advantage that the technic and skill required for high quality workmanship can be concentrated on front ends for several models of receivers without duplication of facilities or waste of technical manpower. Tuners are assembled, tested and then transported to the chassis assembly lines in much the same manner as engines are handled in an automobile assembly plant. The ever present need for standardization is well served in that only two types of front end assemblies are used to tune eleven different models of FM receivers.

Performance Figures

As shown in Fig. 8, the tuner assembly in completed form is enclosed in a metal box for shielding and for mechanical protection and dustproofing. This receiver is a ten-tube model including one tube used as the phonograph preamplifier and is characterized by high performance in the FM bands (3 to 6 microvolts for 20 db quieting), and by genuine band spread of the 25- and 31-meter short wave broadcast bands, as well as electric push button and manual broadcast band tuning. Operation on the short wave spread bands is comparable to communication receiver performance and ease of tuning.

Short wave microphonic howl is completely absent due to use of the guillotine tuner, making the full power output of the receiver usable on all bands. Loop reception is provided on all of the AM bands and power line pick-up is used for local FM reception. Terminal connections are provided, of course, for AM antenna and FM dipole use wherever required.

In conclusion I should like to reflect for a moment on the significance of this development from the standpoint of the receiver engineer. From time to time during the growth of electronics, there have been isolated examples of major advances in the art. The screen grid tube, the variable mu grid and the development of high frequency iron are notable examples. I mention these three because they are fundamental. They represent new tools for the receiver engineer which were not previously available for his use. One can list many instances of advancement in receiver technic such, for example, as the loop antenna or push-button tuning, but thorough analysis will show that advancements of this type are secondary and are made possible only by more fundamental progress such as the examples previously mentioned.

When the FCC assigned the 88 to 108 mc band to FM, the receiver engineer found himself in a dilemma. There were no suitable tools in existence at reasonable cost to solve the problem of tuning, to provide the required order of frequency stability or to make a reasonably clean design for manufacturing in high quantity. The problem of the application of push-buttons to FM is one which is most difficult at the higher frequencies.

The development which is the subject of this paper represents an attempt to solve some of these problems. The guillotine tuner is a new tool, without which good performance and manufacturability would be difficult to obtain. Many problems obviously remain to be solved before 100 mc FM receivers will become commercially a really mass market item. The fundamental advancement needed in the design of FM receivers is tubes plus some other components which are the receiver engineer's tools.

VHF Radio Equipment Speeds Up

Modern two-way FM installations, rapidly coming into widespread use, save much time and greatly improve operating efficiency and safety

• Today, railroad radio saves time and money; that means train radio has come of age; it's here to stay. No longer in the experimental stage, railroad men are not concerned with "will it talk?" but rather "how much time and money will radio save me?" Radio in railroading is here on a permanent basis and is in daily use in all sections of the country. Technical difficulties which made railroad radio communications impractical a few years ago have been licked.

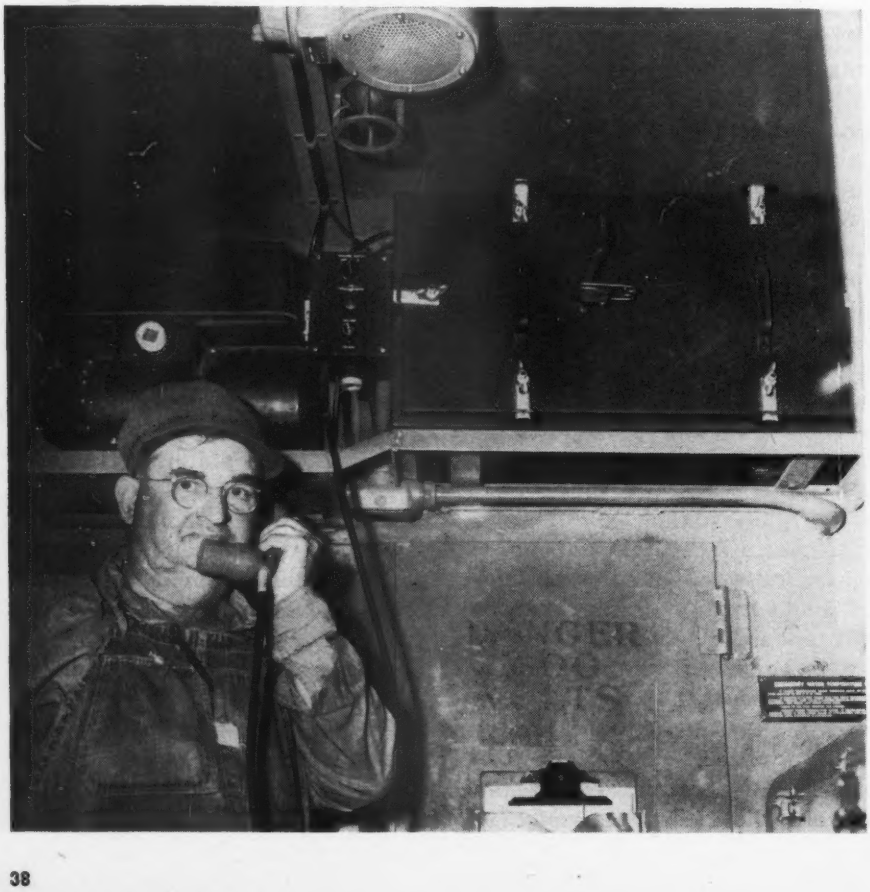
It has been customary, in the past, to say that VHF radio was a "war baby". True, it was used widely during the war and aided substantially in our victory, but train radio was engineered specifically for railroad use and bears no relation to war-born radio except that it functions in the VHF portion of the frequency spectrum.

Railroad radio equipment was designed by leading electronic engineers in close collaboration with railroad communications officers and it admirably meets the rigid requirements which have been specified by the railroads.

Radio is doing an important job in railroad yards and terminals on trains and on marine extensions of railroads. Again, these are not experimental installations. They are permanent installations using standardized production VHF radio equipment. The results of VHF communication are so well known that experimental installations are deemed to be no longer necessary.

There are many typical examples of radio at work in railroading. The following is a list of railroads with permanent installations of Bendix equipment alone which incidentally covers the entire country; this is indicative of the wide spread acceptance of radio communications by the railroads: Chicago, Burlington & Quincy; Atchison, Topeka & Santa Fe; Baltimore & Ohio; Chicago, Milwaukee, St. Paul & Pacific; Elgin, Joliet and Eastern; Gulf, Mobile & Ohio; Western Maryland; Central of Georgia; Chesapeake & Ohio; Pere Marquette; Denver & Rio Grande & Western; St. Louis-San Francisco; Northern Pacific; and the Bessemer & Lake Erie.

Typical installation of Bendix VHF two-way communications equipment on one of the Frisco Diesel switching engines at Springfield



Humping Operations

Just how does train radio save time and money? Railroad men know of many new efficiencies which radio can make possible; here are some actual examples. Prior to the installation of radio at the B & O Newcastle, Pennsylvania, yard, the humping of freight trains was controlled by color light signals. Heavy fog hampered humping operations as the color light signals were often obscured. Fog slowed down operations over 200 days per year.

One of the first permanent railroad installations for humping was made at this yard. A land station controlled from the hump and general yard offices provides communication to locomotives in the classification yard and on the hump.

Railroad Operation

By LEO G. SANDS
Sales Engineer
Bendix Radio Division
Baltimore, Md.

Regardless of visibility, trains can be humped regularly as instantaneous reliable communication is provided by VHF radio.

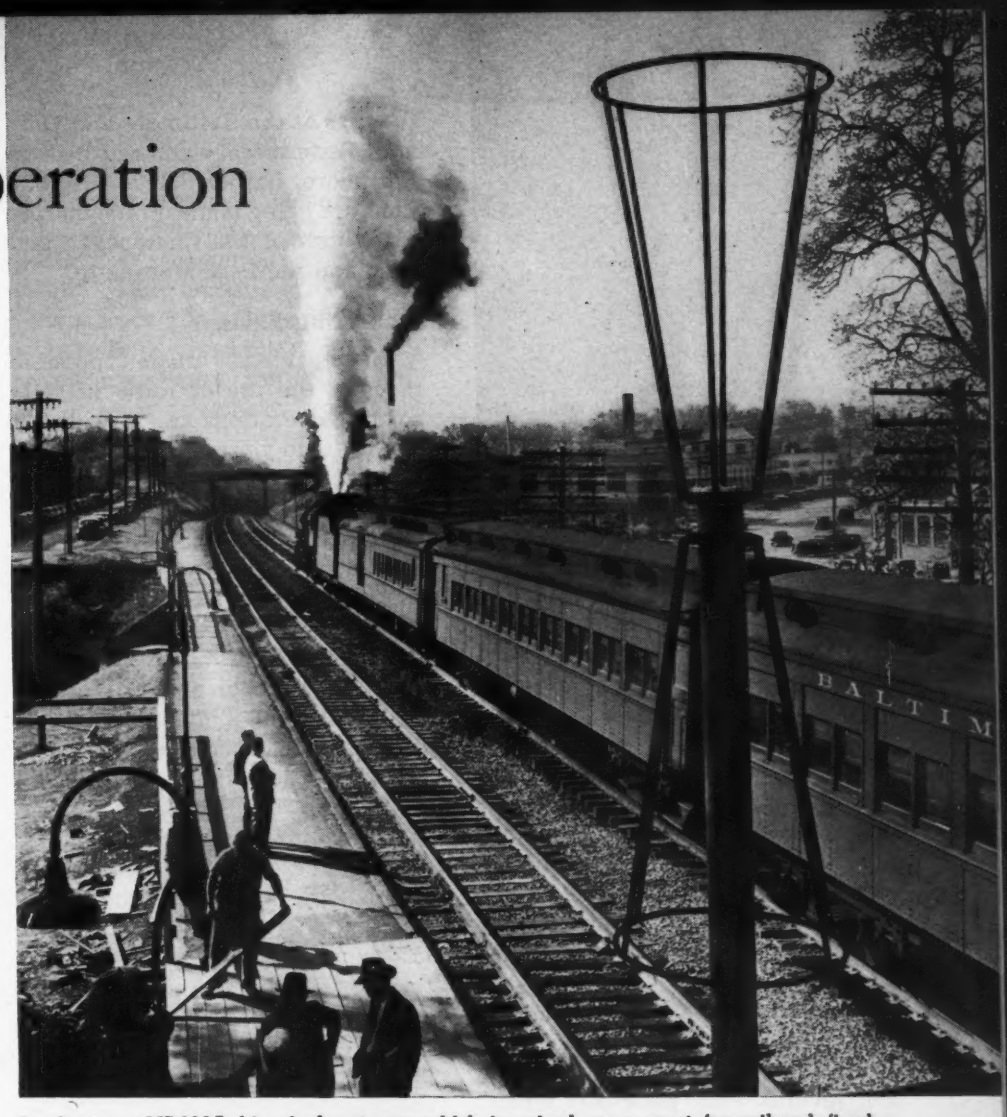
The Burlington, one of the pioneers in the use of radio has more than twenty locomotives completely equipped with two-way VHF radio communications in its sprawling Chicago yards and contemplates a wider use of the new facility.

At Baltimore the crews of diesel-electric switch engines of the Western Maryland railway operating in the huge Port Covington terminal receive their orders from the yardmaster via VHF radio. The land station is located on a tall grain elevator and is remotely controlled from the yard office a quarter of a mile away. Similar installations can be found all over the country and are in actual daily use saving considerable time and money.

The Santa Fe, one of the largest users of radio to date has purchased one hundred and twenty-five VHF communications units. Its radio operation includes yard, end-to-end and marine extension equipment.

A large industrial plant in the south recently equipped its single locomotive and its traffic office with VHF radio to improve the efficiency of its operations in the plant's own rail yard. When a change in orders is made, it will no longer be necessary to hunt for the locomotive in the middle of the night. The dispatcher will merely pick up a handset and talk directly to the engine crew.

End-to-end operation is perhaps the least exploited among the various services. The Burlington, Santa Fe and Milwaukee are among the railroads utilizing VHF radio



Bendix type MS 110A biconical antenna which is raised on a mast for railroad fixed station installation

Bendix VHF train radio in use on the Frisco lines at Springfield, Mo. "Wagon wheel" antenna appears over engine cab

Bendix VHF space radio communications on C&O tug at Newport News with mate talking to boatmaster at off-shore end of pier

for end-to-end communications. Radio has proved its value in this service. Long walks around curves to give visual signals are eliminated.

The Milwaukee road has added portable two-way communications in its end-to-end operation by using several VHF pack-sets which extend normal communication to trackside applications. This provides more convenient operation.

VHF radio has been adopted by several railroads for supervising the operations of their marine extensions. Today, VHF radio is in daily use on the tug boats of the Santa Fe railroad in San Francisco bay, the tugs of the Lackawanna railroad in New York harbor and the tugs of the Baltimore and Ohio and Western Maryland railroads in Baltimore harbor. New installations are being made on the marine extensions of the Chesapeake and Ohio and the Pere Marquette.

Operating Savings

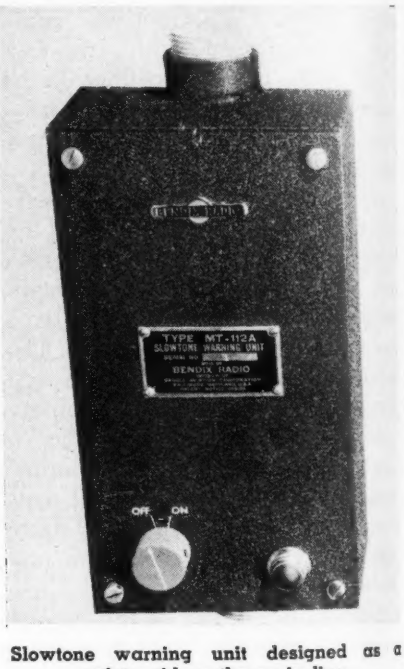
The savings made possible through the use of radio in railroading operations are obvious. At one railroad yard where only three locomotives are equipped with radio, the yardmaster stated that radio permits him to save five engine hours per day. The cost to operate a steam locomotive in the particular yard is estimated at fifteen dollars per hour. Furthermore, the number of cars that can be handled in a given period of time has been increased over 15%.

End-to-end communication provides substantial savings in time and money. The running time of trains can be reduced by avoiding delays incurred through the use of ordinary hand signals. The time lost for repairs when a freight train breaks in two can be shortened materially. During a recent end-to-end run, a car with a hot box condition was set out and the train was under way in 18 minutes rather than the average 45 minutes previously required.

Direct savings through the use of radio communication are most obvious in marine applications. One railroad using VHF radio on its tugs reports that they are saving one hour per shift per boat. In fuel cost alone, this saving is substantial.

VHF radio equipment especially designed for railroad use is being built today on a regular production basis. Several manufacturers are building equipment and at least one manufacturer, who pioneered VHF radio development, reports that immediate deliveries can be made.

From 1944 to 1946 tests were conducted by numerous railroads in conjunction with a few manufacturers to determine the requirements of the equipment and the propagation characteristics of VHF radio in railroad applications. Today, except in rare cases where a very unusual problem exists, such experimental programs have been discontinued and VHF communication is being installed as a permanent standard facility. The railroads and the manufacturers are satisfied that VHF radio will provide adequate communication facilities and "watchful waiting" is a thing of the past. Railroad officials know that VHF radio is ready to save time and money.



Slowtone warning unit designed as a safety aid on the main line

A typical railroad yard radio installation consists of a land station controlled from one or more dispatch points and several mobile radio stations on locomotives. The equipment at the land station and mobile stations is essentially the same except for control units and power supplies.

Several types of antennas for use at VHF land stations have been

Assembly line in the Bendix Towson plant, showing production of VHF railroad equipment from "raw" chassis to finished product

developed. If communication over a fairly great range is desired, an efficient array mounted on a tall structure is used. For short ranges as encountered in humping operations, other types may be used.

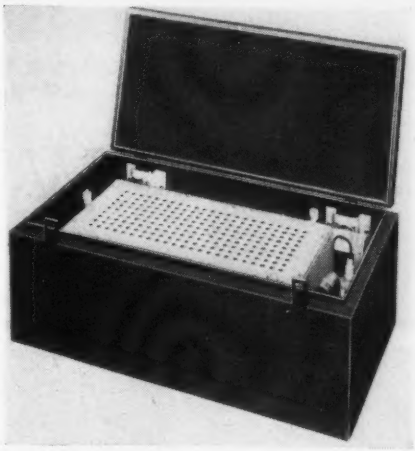
A typical land station is the biconical array which affords a power gain of 2½:1 as compared with a half wave dipole. This particular antenna is a broad band non-directional radiator and is in production on a quantity basis. When connected to the transmitter through a 52-ohm coaxial cable, the standing wave ratio is less than 1.5:1 anywhere between 152 and 162 megacycles.

Antenna Installations

Antennas for installation on locomotives and trains must meet more rigid specifications than those for other types of mobile applications. They must be sturdy enough to support the weight of a man and must resist the corrosive effects of the gas in coal smoke. The "wagon-wheel" antenna, so named because of its physical structure, is the most widely used type of mobile railroad antenna. It is a top loaded quarter-wave vertical radiator with a ground plane.

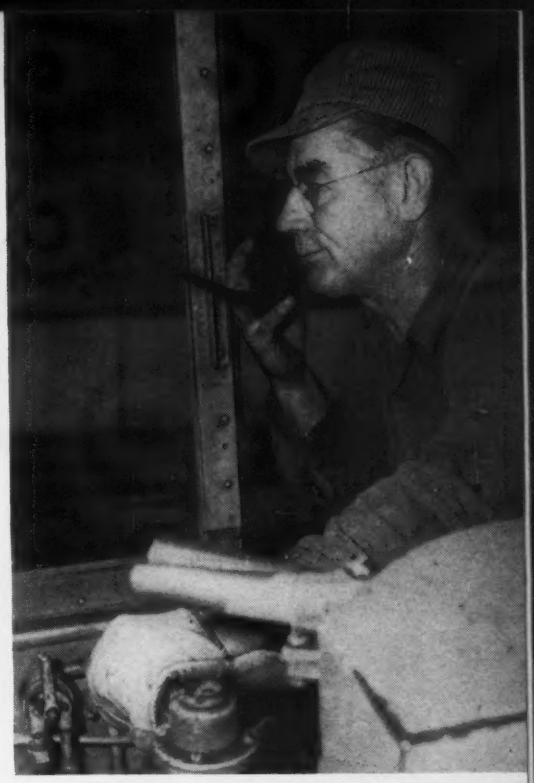
A typical steam locomotive installation by Bendix consists of a wagonwheel antenna, communications unit, dynamotor, control unit, handset, and loudspeaker. The communications unit is shock mounted in a hermetically sealed sheet steel case and consists of a transmitter and receiver. The coaxial cable and inter-connecting wires are enclosed in conduit. The dynamotor is powered by a steam turbo generator and supplies the direct current for plate, bias, filament and relay voltages to the communications unit.

A typical railroad communications unit is illustrated. The transmitter and receiver are combined on the same chassis to simplify maintenance and reduce inter-unit wiring. Both transmitter and receiver are crystal controlled and can be used anywhere in the 152 to 162 mc band. Operation on as many as five channels without retuning is permitted through the selection of the proper crystals. The crystals are selected by operating the channel selector switch on the control box which actuates a stepper relay. The highest and lowest channels must be within 1.2 mc and the channels should be separated by at least 120 kc.



Type MRT-IB VHF FM two-way railroad communications unit showing moisture-proof sheet metal housing. Unit may be mounted in any position

Phase modulation is used in the Bendix type MRT-1B transmitter, resulting in a frequency deviation of plus and minus 15 kc. A compressor circuit in the speech amplifier prevents over swinging of the carrier. Transmitter power output is approximately 15 watts

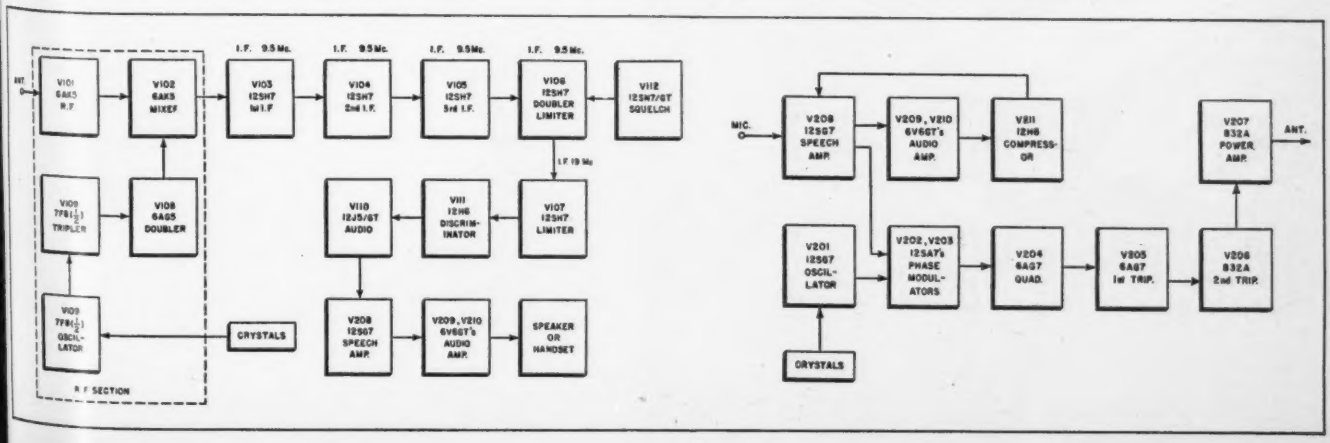


Typical installation of Bendix VHF train radio in locomotive cab. More than 18 railroads have permanent installations

The Bendix type MRT-1B FM receiver is a superheterodyne but with unique characteristics. The radio frequency stage and mixer are followed by three stages of intermediate frequency amplification at 9.5 mc. The first limiter stage acts as a doubler and its output is tuned to 19 mc. as are the second limiter and discriminator stages. This feature permits higher gain without feedback as the input and output of the IF amplifier are at different frequencies. Positive squelch operation is obtained on signals well below one microvolt. Selectivity is great enough to permit operation on a train alongside another train

(*Continued on page* 110)

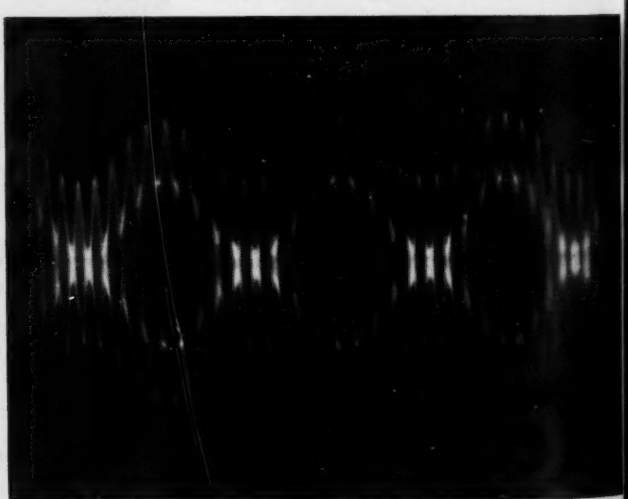
Block diagrams showing the arrangement of components in the Bendix VHF type MRT-IB receiver section (left) and the transmitter section



General view of some of the antennas from which WWV continuously broadcasts 8 standard frequencies

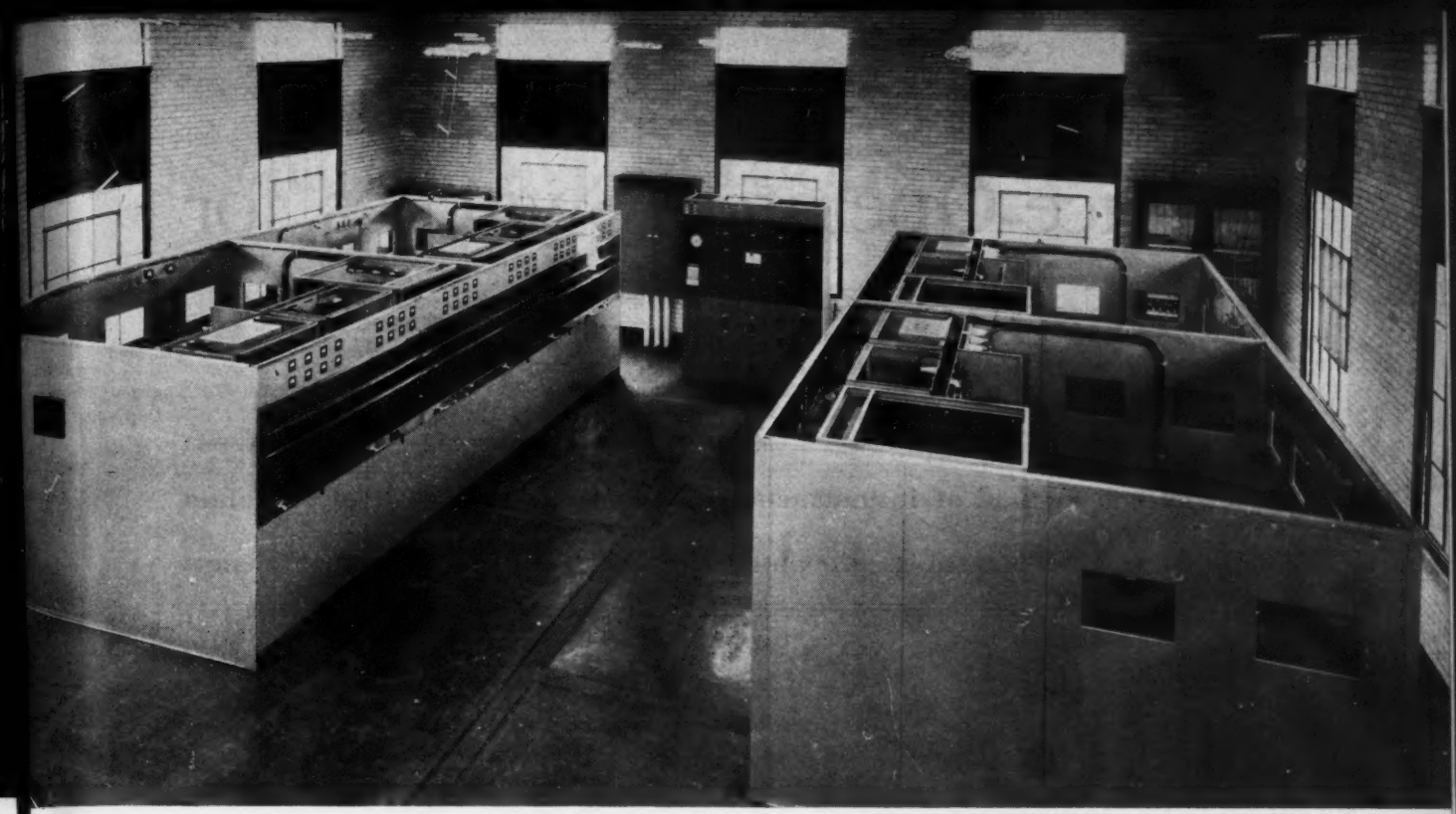
WWV — Worl

The building housing the 8 transmitters which operate at frequencies of 2.5, 5, 10, 15, 20, 25, 30 and 35 mc



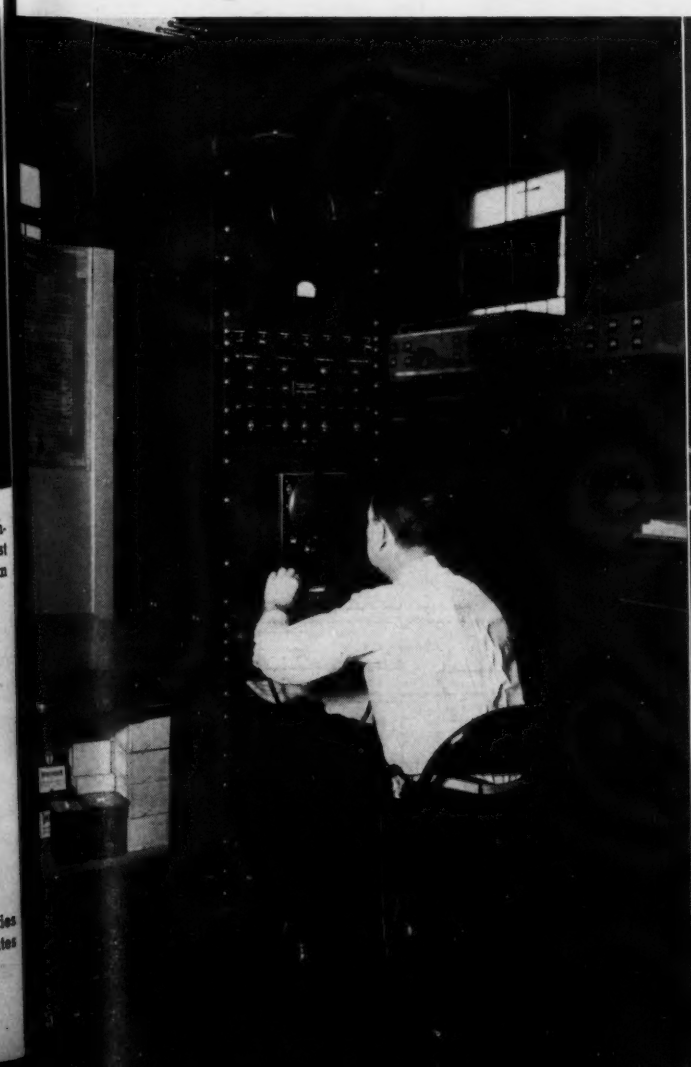
'Scope picture of two standard audio frequencies, 440 cps (standard musical pitch A above middle C) and 4000 cps, broadcast continuously on 10, 15, 20, and 25 mc at an accuracy better than 1 part in 50 million

One of duplicate units which generate standard audio frequencies and time intervals the latter announced in code every 5 minutes day and night

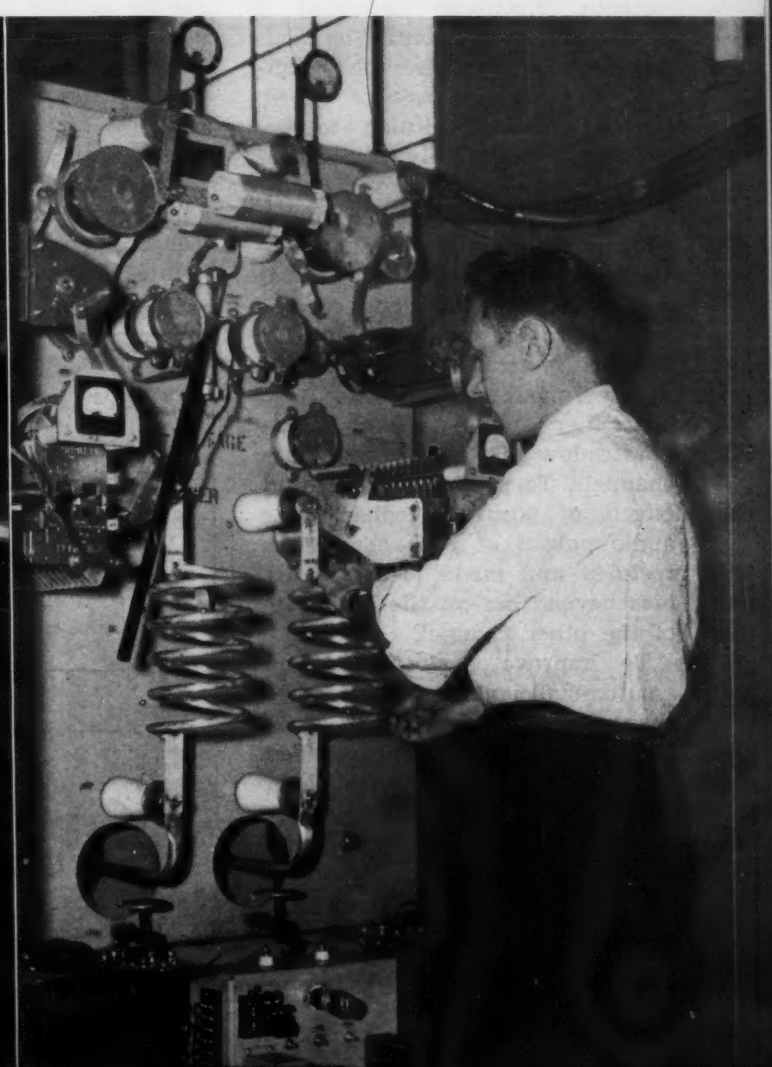


Interior view of the National Bureau of Standards radio station showing 4 of the 8 transmitters. In addition to standard frequency signals and time and musical pitch, warnings of ionosphere and propagation disturbances are broadcast

Standard Frequency Generator



Transmitter monitor panel, which indicates the operating condition of each of the transmitters, continuously watched



Close-up view of one of the high-power output stages, basic control being by quartz crystal which is temperature stabilized

Voice-Operated Switches for Interphones

Abstracted from the French*
By JOSEPHA E. ZENTNER, PH.D.
Digest Editor, TELE-TECH

French method of instantaneous electronic switching involves sound control of bias to assure automatic, reliable, rapid channel change

• Most conventional interphone systems include a hand-operated, and therefore inconvenient, transmit-receive switch. An alternative to the hand-operated switch is the voice-operated relay. However, the considerable delay time introduced by a mechanical relay frequently causes the beginning of words to be suppressed.

To eliminate these disadvantages and assure proper operation, voice-operated, practically instantaneous, electronic switching is proposed. Several control methods are suitable to realize the principle.

One possible solution to the problem is alternately to interrupt the two channels, for example by a trapezoidal 11,000 cycle signal. This, however, only prevents electrical feedback, because acoustical waves persist for a long enough time to provide sufficient feedback. Such a system is more suitable with earphones.

Another simple system incorporates low gain amplifiers in both channels. To prevent the harmful effects of positive feedback, the audio output of each channel is rectified and made to negatively bias beyond cut-off the last stage of the other channel.

To improve performance and assure sufficient gain, the two channels are equipped with separate power supplies. The rectified audio output of the channel in operation provides a cut-off potential for the suppressor grid of the first tube of the other channel. Interruption of the audio signal in the first channel causes cessation of the rectifier current conditioning the second channel for operation.

Alternatively, the output tubes of both channels are initially biased beyond cut-off. The plate currents of the first tubes are amplified in separate stages, rectified and each applied to the last tube of its own channel, conditioning it to carry current, while effecting cut-off of the first tube in the other channel.

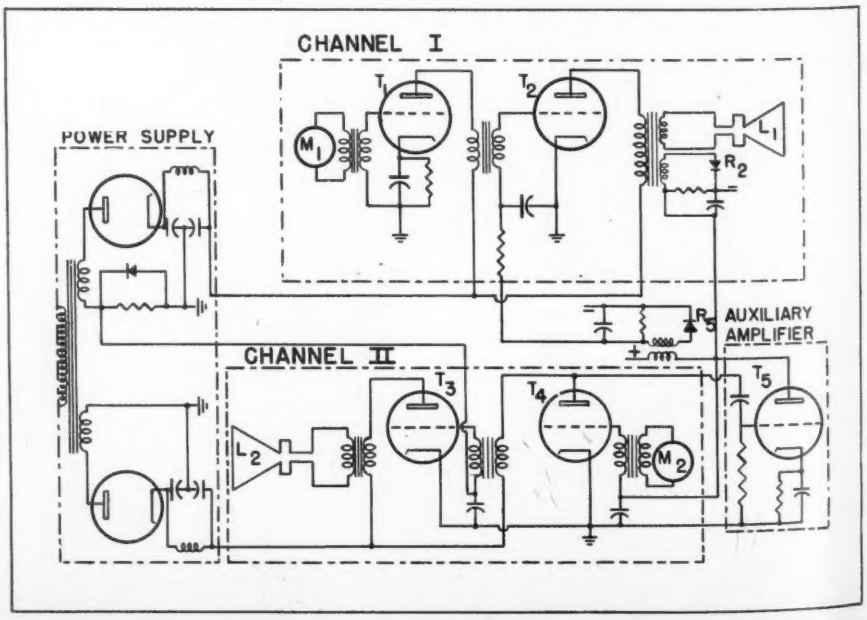
The use of throat microphones, responsive only to mechanical vibrations and not to the sound waves of the air, obviously would prevent acoustical feedback from a nearby loudspeaker. From a technical point-of-view, this constitutes a simple solution to the problem. However, the inconvenience to the telephone user may be justified only at very noisy locations.

The circuit illustrated was considered the most suitable for industrial applications and put into production. Channel I is normally in operative condition and gives immediate peak response, while the output tube, T_3, of channel II is normally biased beyond cut-off by the negative potential taken off the power supply for channel I. The rectifier R_2, connected to the last stage of channel I, supplies a negative bias to the grid of tube T_4, so that both tubes of channel II are interrupted as soon as channel I carries signal current.

The time constant of the circuit associated with rectifier R_2 is so

(*Continued on page* 109)

Two channel interphone system using voice operated electronic circuits for channel switching



*Pierre Jeanlin in Toute la Radio, No. 112, Jan., 1947, pp. 52-55.

Operating FM Stations Total 300

● The following FM stations are now in operation, or shortly will be. According to FCC reports nearly all FM stations are using interim equipment pending full construction. Some are operating equipment in the old FM band on a temporary basis. This list has been compiled from FCC reports in conjunction with results of a survey made by TELE-TECH. Engineering personnel responding to the survey indicated that stations reported here were well on the way if not in actual operation as we go to press.

Radio Station and Address — Chief Engineer

ALABAMA

WAFM—Protective Life Bldg., Birmingham 3 ....N. S. Hurley
WBHP—FM—318 W. Clinton St., Huntsville ....W. G. Harris
WRLD—2 Stonewall, Lanett.....L. W. Martin
WKRG—FM—Telegraph Road, Mobile. W. H. Murphree

CALIFORNIA

KARM—FM—1333 Van Ness Ave., Fresno
KRFM—330 Patterson Bldg., Fresno....H. R. Brown
KHJ—5515 Melrose Ave., Hollywood 38. F. M. Kennedy
W6XAO—FM—3800 Mt. Lee Drive, Hollywood 28 ....H. W. Jury
KGER—435 Pine Ave., Long Beach 2.....J. E. Tapp
KTML—FM—202 W. 1st St., Los Angeles 53 ....R. A. Monfort
KROW—FM—464-19th St., Oakland....C. E. Downey
KWBR—FM—327-21st St., Oakland 12..F. W. Morse
KOCS—FM—222 East "B" St., Ontario...John Hicks
KWKW—FM—425 East Green St., Pasadena 1 ....P. W. Spargo
KRCC—202 Tenth St., Richmond.....Herb Watson
KPOR—FM—3401 Russell St., Riverside. R. T. Sampson
KFBK—FM—911-7th Ave., Sacramento 4. Stam Sronce
KCRA—FM—10th & Jay Sts., Sacramento ....Marvin Myers
KFXM—FM—512 Fifth St., San Bernardino ....G. W. Ewing
KFMB—FM—1375 Pacific Blvd., San Diego
KJBS—FM—1470 Pine St., San Francisco 9 ....Wayne Berthold
KRON—901 Mission St., San Francisco..R. A. Isberg
KSFO—FM—One Nob Hill Circle, San Francisco 2 ....R. A. Howard
KLOK—FM—40 West San Antonio St., San Jose ....J. T. Bindner
KVEC—FM—851 Higuera St., San Luis Obispo ....Earle Travis
KRJM—Santa Maria Daily Times, Santa Maria ....K. B. Young
KSRO—FM—425 Mendocino Ave., Santa Rosa ....Verne Hassett
KGDM—FM—519 E. Market St., Stockton. L. R. Amoo

CONNECTICUT

WDRC—FM—750 Main St., Hartford 4..I. A. Martino
WTIC—FM—26 Grove St., Hartford 15..H. D. Taylor
WKNB—FM—213 Main St., New Britain ....W. A. Atkinson
WBIB—FM—157 Church St., New Haven..I. M. Small
WNLC—FM—281 State St., New London ....W. J. Tucker, Jr.
WSTC—FM—270 Atlantic St., Stamford ....E. L. Markman

DELAWARE

WILM—FM—920 King St., Wilmington ....H. E. Kennedy

DISTRICT OF COLUMBIA

WASH—FM—1319 F St., N.W., Washington 4 ....Leigh Kimball
WINX—FM—8th & Eye Sts., N. W., Washington 1 ....R. E. Cannon, Jr.
WRC—FM—724 14th St., N. W., Washington ....A. E. Johnson
WWDC—FM—1000 Connecticut Ave., Washington 6 ....Ross Beville

FLORIDA

WMBR—FM—675 S. Main St., Jacksonville 7 ....J. C. Bell
WIOD—FM—600 Biscayne Blvd., Miami 30 ....M. C. Scott
WQAM—FM—327 N. E. First Ave., Miami 31 ....Earl Lewis
WKAT—FM—1759 N. Bay Rd., Miami Beach
WWPG—FM—South Ocean Blvd., Palm Beach ....Clyde Walkden
WCOA—FM—P.O. Box 1669, Pensacola..Harold Heath
WTSP—FM—3505-4th St. No., St. Petersburg ....W. D. Mangold

GEORGIA

WGBA—1213½ Broadway, Columbus.....Jack Wisely
WRBL—FM—1420 Second Ave., Columbus ....J. A. Gamble
WBML—FM—Macon.....H. S. Goodrich
WMAZ—FM—666 Cherry St., Macon
WRGA—501 Broad St., Rome.....R. A. Starr
WSAV—FM—Liberty National Bank Bldg., Savannah ....M. E. Thompson
WTOC—FM—516 Abercorn St., Savannah..Reeve Owen

IDAHO

KIDO—FM—Hotel Boise, Boise ....H. W. Toedtemeier, J. A. Johntz
KFXD—1024-12th Ave. So., Nampa....Edward Hurt
KTFI—FM—241 Main Ave. W., Twin Falls ....George Malone
KSEI—FM—Pocatello.....H. H. Fletcher

ILLINOIS

WJBC—FM—209 E. Washington, Bloomington ....Ted Bailey
WBBM—FM—410 N. Michigan Ave., Chicago 11 ....George Sherman
WBEZ—FM—228 No. LaSalle St., Chicago 1 ....E. H. Andresen
WDLM—820 N. LaSalle St., Chicago 10...A. P. Frye
WEFM—135 S. LaSalle St., Chicago 3....R. A. Utter
WGNB—FM—441 North Michigan Ave., Chicago 11 ....G. W. Lang
WEHS—6138 W. Cermak Road, Cicero 50..E. P. Hayes
WSOY—FM—351 N. Main St., Decatur ....P. A. Wnorowski
WEAW—FM—2425 Main St., Evanston. Harry Hok, Jr.
WFJS—6 North Galena Ave., Freeport...J. D. Holmes
WJPF—Herrin .....Gino Monaco
WKAN—FM—183 N. Schuyler Ave., Kankakee ....R. L. Harrell, Jr.
WMIX—FM—121½ N. 9th St., Mt. Vernon ....Robert Cleveland
WHBF—Safety Bldg., Rock Island.....R. J. Sinnett
WCVS—FM—523 E. Capital Ave., Springfield ....H. L. Dewing
WIUC—FM—1010 S. Wright St., Urbana ....J. R. Brugger
WKRS—116 Madison St., Waukegan.....F. W. Just

INDIANA

WMLL—519 Vine St., Evansville 8....Erwin Schoeny
WOWO—FM—925 S. Harrison St., Ft. Wayne 2 ....B. H. Ratts
WABW—445 N. Pennsylvania St., Indianapolis ....J. A. Lovell
WLBC—FM—P. O. Box 271, Muncie....M. M. Crain
WCTW—FM—202½ S. 14th St., New Castle ....Ralph Atkinson
WSBF—226 W. Colfax Ave., South Bend 26 ....H. G. Cole

IOWA

KBUR—FM—National Bank Bldg., Burlington ....John Gallino
KSO—FM—10th and Grand, Des Moines 9 ....F. E. Bartlett
WHO—FM—914 Walnut St., Des Moines..P. A. Loyet
KSUI—FM—State University of Iowa, Iowa City ....S. J. Ebert

KANSAS

KTJS—Topeka
WIBW—FM—1035 Topeka Blvd., Topeka ....K. G. Marguardt
KFH—FM—KFH Bldg., Wichita 2...Amos Dadisman

KENTUCKY

WSON—FM—Zion Road, Henderson.....V. R. Nunn
WBKY—FM—University of Kentucky, Lexington ....R. Westerfield
WLAP—FM—Short and Walnut Sts., Lexington ....Sanford Helt
WBOX—FM—Kentucky Home Life Bldg., Louisville 2 ....P. W. Esten
WCJT—300 West Liberty St., Louisville 2 ....O. W. Towner
WKYC—509 Kentucky Ave., Paducah.....C. G. Sims
WPAD—FM—4th & Broadway, Paducah..U. C. Morris

LOUISIANA

KPDR—FM—1710 Jackson St., Alexandria 7 ....Tom Marhefka
WBRL—444 Florida St., Baton Rouge 1..V. E. Dudley
WJBO—444 Florida St., Baton Rouge 1..V. E. Dudley
WDSU—FM—Monteleone Hotel, New Orleans ....L. G. Riddle
WSMB—FM—901 Canal St., New Orleans..H. G. Nebe
WWLH—FM—Roosevelt Hotel, New Orleans 12 ....J. D. Bloom, Jr.

MAINE

WARY—645A Congress St., Portland..R. W. Hodgkins
WGAN—FM—645A Congress St., Portland 3 ....R. W. Hodgkins
WMTW—FM—212 Middle St., Portland. I. B. Robinson

MARYLAND

WITH—FM—7 E. Lexington St., Baltimore
WFMD—FM—Frederick.....J. W. Robertson
WJEJ—Hagerstown .....George MacIntire
WGAY—FM—Kemp Mill Road, Silver Spring ....C. K. Chrismon

MASSACHUSETTS

WBZ—FM—275 Tremont St., Boston 16 ....W. H. Hauser
WIXHR—FM—447 Concord Ave., Cambridge 38 ....R. J. Cosman
WFMR—555 Pleasant St., New Bedford ....W. R. Hutchins
WBEC—FM—Eagle St., Pittsfield....Donald Coleman
WBZA—FM—Hotel Kimball, Springfield 3 ....H. E. Randol
WTAG—FM—18 Franklin St., Worcester 1 ....E. A. Browning

MICHIGAN

WGUN—Hutzel Bldg., Ann Arbor.....G. D. Stearns
WELL—FM—Battle Creek.....E. J. Stone
WBCM—FM—100 Center Ave., Bay City
WENA—FM—630 W. Lafayette Ave., Detroit 31 ....Carl Wesser
WJR—FM—2100 Fisher Bldg., Detroit 2. G. F. Leydorf
WLOU—10 Witherell St., Detroit
WFRS—316 Murray Bldg., Grand Rapids 2 ....G. A. Thorpe
WLAV—FM—6 Fountain St., N. E., Grand Rapids 2 ....Lee Stevens
WMLN—67 Cass St., Mt. Clemens....W. A. Schattler

MINNESOTA

KYSM—FM—101 North Second St., Mankato ....James Houts
WTCN—FM—1204 Wesley Temple Bldg., Minneapolis 4.....J. M. Sherman
KROC—FM—100 1st Ave., Rochester...F. C. Clarke
KSTP—FM—Hotel St. Paul, St. Paul 2..J. N. Fricker

MISSOURI

WMBH—FM—6th & Main Sts., Joplin..Richard Meek
KCFM—1515 Commerce Bldg., Kansas City 6 ....Karl Troeglen
KMBC—FM—10th & McGee Sts., Kansas City 6 ....A. R. Moler
KOZY—406 W. 34th St., Kansas City 2..E. L. Hendry
WDAF—1729 Grand Ave., Kansas City..J. A. Flaherty
KFUO—FM—801 De Mun Ave., St. Louis 5 ....A. H. Wiese
KMOX—FM—12th and Spruce Sts., St. Louis 2 ....L. McC. Young
KWGD—FM—1133 Franklin St., St. Louis 1 ....W. R. Chapin
KWK—FM—Hotel Chase, St. Louis.....N. J. Zehr
WIL—FM—Grand Ave. & Lindell Blvd., St. Louis 8 ....Edward Goodberlet

Radio Station and Address — Chief Engineer

NEBRASKA

KFAB—Sharp Bldg., 13th & N Sts., Lincoln ....M. W. Bullock
KOAD—FM—Omaha 2.....F. E. Shopen

NEVADA

KENO—FM—Box 1310, Las Vegas....Maxwell Kelch

NEW HAMPSHIRE

WLOB—Main St., Claremont.....W. J. Hill
WMNE—FM—Gorham.....I. B. Robinson
WKNE—FM—17 Dunbar St., Keene ....E. F. Batchelder, Jr.

NEW JERSEY

W2XMN—W2XEA—Route 9W, Alpine..P. H. Osborn
WSNJ—Bridgeton .....Francis Fekel
WAAW—FM—11 Hill St., Newark 2....F. V. Bremer

NEW YORK

WNBF—FM—Arlington Hotel, Binghamton ....L. H. Gilbert
WBEN—FM—Hotel Statler, Buffalo
WBNY—485 Main St., Buffalo .....T. R. Vines
WEBR—23 North St., Buffalo 2
WFSS—FM—Box 82, Coram, L. I...N. B. Munhofen
WKNP—FM—114 Walnut St., Corning....A. N. Bell
WENY—Elmira.....T. A. Greene
WWHG—FM—Canisteo St., Hornell..W. N. Amidon
WHCU—FM—Savings Bank Bldg., Ithaca.True McLean
WABF—654 Madison Ave., New York
WBAM—FM—444 Madison Ave., New York 22 ....J. R. Poppele
WCBS—FM—485 Madison Ave., New York 22 ....Henry Grossman
WGHF—FM—10 East 40th St., New York 16 ....H. C. Florance
WGYN—5808—70 Pine St., New York 5..Roy Olerud
WMGM—FM—1540 Broadway, New York 19 ....P. W. Fuelling
WNBC—FM—30 Rockefeller Plaza, New York 20 ....F. A. Wankel
WNYC—Centre and Duane Sts., New York 7 ....W. H. Pitkin
WQXR—FM—730 Fifth Ave., New York ....R. D. Valentine
WHLD—FM—Hotel Niagara, Niagara Falls.Dean Hiatt
WHVA—Poughkeepsie .....Marvin Seimes
WHEF—40 Franklin St., Rochester
WHFM—111 East Ave., Rochester..Kenneth Gardner
WRNY—FM—191 East Ave., Rochester 4 ....Felix Bonvouloir
WRUN—Rome
WBCA—408 State St., Schenectady 5.....D. S. Hoag
WGFM—Schenectady.....W. J. Purcell
WNDR—FM—306 S. Salina St., Syracuse 2 ....P. H. Lee
WSYR—214 Harrison St., Syracuse 2....A. Belle Isle
WTRI—92 Fourth St., Troy.....A. H. Chismark
WIBX—FM—187 Genesee St., Utica 2..J. T. Dowdell
WFAS—FM—8 Church St., White Plains ....F. A. Seitz

NORTH CAROLINA

WPBH—FM—McGlobon St., Aloskie
WISE—Asheville .....Roger Montgomery
WLOS—Battery Park Hotel, Asheville....P. A. Greer
WBBB—310½ So. Main St., Burlington..Berry Tysor
WFNC—FM—114 Anderson St., Fayetteville ....O. A. Lehr
WGNC—FM—Gastonia .....W. C. Groves, Jr.
WGBR—FM—Borden Bldg., Goldsboro ....D. B. Trueblood
WFMY—FM—Greensboro .....Paul Dillon
WMFR—164 So. Main St., High Point..R. L. Moore
WRAL—FM—130 So. Salisbury St., Raleigh ....S. H. Brown
WGTM—FM—Wilson.....W. H. Malone
WAIR—Pepper Bldg., Winston-Salem 3....Lee King
WSJS—FM—Winston-Salem 1.....Phil Hedrick

OHIO

WHBC—FM—550 Market Ave. So., Canton 2 ....K. L. Sliker
WCMW—FM—317 W. Tuse. St., Canton 2..R. Woodin
WCTS—FM—Hotel Alms, Cincinnati....G. A. Wilson
WLWA—Crosley Square, Cincinnati 2..R. J. Rockwell
WSAI—115 East 4th St., Cincinnati 2..W. E. Symons
WBOE—FM—1380 E. 6th St., Cleveland 14.N.A.Neal
WCOL—33 North High St., Columbus 15 ....Leo DeConnick
WELD—33 North High St., Columbus 15.L. H. Natager
WHKB—22 East Gay St., Columbus 15..W. C. Minor
WHIO—FM—45 South Ludlow St., Dayton 1 ....E. L. Adams
WFOB—FM—125 So. Main St., Fostoria..L. W. Harry
WFRO—907 West State St., Fremont..G. Swartzlander
WCLT—FM—National Drive, Newark....B. E. Windle
WSTV—FM—428 Market St., Steubenville ....C. Shepherd
WSPD—FM—136 Huron St., Toledo ....Bill Stringfellow
WTLO—FM—406 Arcadia St., Toledo 10 ....J. W. Sheehan
WTOD—FM—206 Michigan St., Toledo..R. R. Sowers

Radio Station and Address — Chief Engineer

WFMJ—101 West Boardman St., Youngstown 3 ....F. A. Dieringer

OKLAHOMA

KVSO—FM—Chickasha & N. W. Blvd., Ardmore ....J. C. Molloy
KMUS—FM—412 Court St., Muskogee ....D. W. Hoisington
KOKU—FM—Faculty Exchange, Norman..Remy Perot
KOCY—FM—Plaza Court Bldg., Oklahoma City 3 ....R. R. Freeland
KTOK—FM—1800 W. Main St., Oklahoma City ....Clifford Easum
WKY—FM—1st and Bwdy, Oklahoma City
KGFF—FM—9th & Bell Sts., Shawnee ....Salvatore Riciotti
KOAG—FM—Oklahoma A & M College, Stillwater ....C. E. Smith

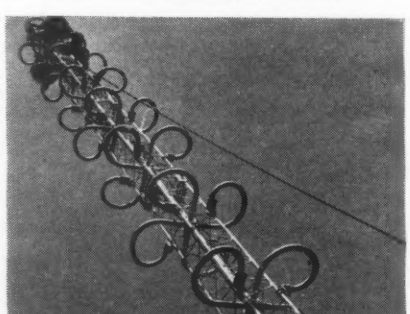
OREGON

KWIL—FM—15th and Elm Sts., Albany ....H. A. Davidson
KALE—FM—Box 31, Portland 7....A. E. Richmond
KGW—FM—Oregonian Bldg., Portland ....H. C. Singleton
KOIN—FM—Broadway and Salmon Sts., Portland ....L. S. Bookwalter
KPFM—Box 1230, Portland 7.....W. K. Dallas
KPRA—FM—1011 S. W. 6th Ave., Portland 4 ....Frank Hovel

PENNSYLVANIA

WSAN—FM—39 N. 10th St., Allentown ....R. H. Musselman

CLOVERLEAF ANTENNA



Designed for any power level up to 50 kw, Western Electric's Cloverleaf FM antenna comprises an array of two or more vertically stacked radiating units. Gain with eight units is 4.7.

WGPA—FM—426 Brodhead Ave., Bethlehem ....Edwin Rybak
WABX—FM—604A Maclay St., Harrisburg 6 ....Walter Deemer
WHP—FM—Telegraph Bldg., Harrisburg
WJAC—FM—Tribune Annex, Johnstown..N. L. Straub
WEAX—R.D. #3, Lancaster
WGAL—FM—4-10 W. King St., Lancaster ....J. E. Mathiot
WMCK—FM—Elks Temple, 516 Market St., McKeesport.....C. W. White
WKST—FM—110 E. Lincoln Ave., New Castle ....R. S. Emch
KYW—FM—1619 Walnut St., Philadelphia 3 ....I. N. Eney
WCAU—FM—1622 Chestnut St., Philadelphia 3 ....J. G. Leitch
WFIL—FM—Widener Bldg., Philadelphia
WIP—FM—35 South 9th St., Philadelphia 7 ....C. C. Harris
WPEN—FM—1528 Walnut St., Philadelphia 2 ....R. D. Compton
KDKA—FM—Grant Bldg., Pittsburgh 19.T. C. Kenney
KQV—FM—201 Chamber of Commerce Bldg., Pittsburgh 19.....R. F. Hunt
WMOT—FM—Hotel Keystone, Pittsburgh 30 ....H. R. Kaiser
WEEU—FM—530 Penn St., Reading..H. E. Schearer
WARM—FM—721 Linden St., Scranton 10 ....A. W. Oschmann
WMBS—FM—Main St., Uniontown.....W. Henzly
WBRE—FM—62 S. Franklin St., Wilkes-Barre ....Chas. Sakoskie
WIZZ—FM—156 Prospect St., Wilkes-Barre ....A. E. Marth

Radio Station and Address — Chief Engineer

SOUTH CAROLINA

WFBC—FM—Poinsett Hotel, Greenville ....W. C. Etheridge
WMRC—FM—Greenville.....G. D. Tate
WSPA—FM—224 E. Main St., Spartanburg ....H. R. Beckholt

TENNESSEE

WOPI—FM—310 State St., Bristol..R. N. Robinson
WAPO—FM—Read House, Chattanooga 2 ....B. B. Barnes
WTJS—FM—Jackson.....R. M. Gordon
WKPB—FM—618 Gay St., Knoxville 6 ....H. G. Price
WROL—FM—Hamilton Nat. Bank Bldg., Knoxville ....James Gilbert
WMC—FM—Third and Madison Ave., Memphis 1 ....E. C. Frase, Jr.
WSIX—FM—Nashville Trust Bldg., Nashville 3 ....Dr. Fred Schumann
WSM—FM—301 7th Ave. North, Nashville 3 ....Geo. Reynolds

TEXAS

KRBC—FM—Abilene.....J. B. Casey
KGNC—FM—Radio Bldg., Amarillo....W. H. Torrey
KAMT—FM—College Station.....F. J. Sasolik
KERA—FM—1122 Jackson St., Dallas 2 ....Raymond Collins
KRLD—FM—Adolphus Hotel, Dallas 1..R. M. Flynn
KDNT—FM—300 W. Ross St., Denton.H. V. Shepard
KGBS—FM—Box 711, Harlingen.....W. O. Porter
KOPY—S. Standard Bldg., Houston..E. P. Hundorff
KPRC—FM—Lamar Hotel, Houston 2.H. T. Wheeler
KXYZ—Gulf Bldg., Houston 2.....G. R. Chinski
KISS—FM—National Bank of Comm. Bldg., San Antonio 5....E. E. Case
KTSA—FM—P. O. Box 1161, San Antonio 6 ....W. G. Egerton
KYFM—FM—Ave. E at Third St., San Antonio ....R. R. Hayes
WOAI—FM—1031 Navarro St., San Antonio ....Fred Sterling
KCMC—FM—317 Pine St., Texarkana ....Harvey Robertson
KGKB—FM—115 S. College Ave., Tyler ....J. B Sheppard
KVWC—FM—1813 Wilbarger St., Vernon ....H. F. Ridgway
KTRN—FM—717—7th Ave., Wichita Falls ....W. W. Roberston

UTAH

KDYL—FM—143 S. Main St., Salt Lake City 5 ....J. M. Baldwin
KSL—FM—Union Pacific Bldg., Salt Lake City ....C. R. Evans
KUTA—FM—29 South State St., Salt Lake City 3 ....C. W. Bell

VIRGINIA

WBTM—FM—Hotel Danville, Danville. Lyle Motley
WSVA—FM—Main & East Market St., Harrisonburg ....W. L. Brown
WLDC—FM—P. O. Box 680, Lynchburg.E. B. Lemon
WLVA—FM—Lynchburg ..... John Orth
WGH—FM—2400 West Ave., Newport News ....C. A. Runyon
WSAP—FM—Professional Bldg., Portsmouth ....F. F. Clair
WCOD—FM—3301 W. Broad St., Richmond 20 ....W. H. Wood
WINC—FM—WINC Bldg., Winchester.Philip Whitney

WASHINGTON

KWLK—FM—National Bank of Commerce, Longview ....John Van Vorhees
KEVR—FM—2102 Smith Tower, Seattle 22 ....A. A. Shultz
KRSC—FM—2939 4th St. South, Seattle 4 ....G. A. Freeman

WEST VIRGINIA

WCFC—FM—305 Reservoir Rd., Beckley.G. W. Yazell
WJLS—FM—WJLS Bldg., Beckley....A. J. Ginkel

WISCONSIN

WBNB—FM—413 Pleasant St., Beloit ....W. M. Morton, Jr.
WJPG—FM—Green Bay.....Dan Gellerup
WKBH—FM—409 Main St., LaCrosse..Alvin Leeman
WHA—FM—Radio Hall, Univ. of Wis., Madison ....John Stiehl
WIBA—FM—110 E. Main St., Madison 3 ....Norman Hahn
WEMP—FM—710 No. Plankinton St., Milwaukee 2 ....Roland Paske
WJMC—FM—1615 So. Main St., Rice Lake ....Robert Kolsky
WDUL—Superior

WYOMING

KFBA—FM—Plains Hotel, Cheyenne...W. C. Grove

Conditional Grants, CPs Top 500

In addition to these Construction Permits and Conditional Grants, there are now before FCC for processing nearly 300 Applications for new FM stations. In many cases holders of CPs and Conditional Grants currently are operating through use of temporary facilities.

Radio Station by Call Letters (if assigned); otherwise Licensee — Chief Engineer

ALABAMA

WHMA—FM—1330 Noble St., Anniston ....James Hudson
Thomas N. Beach, 112 N. 21st St., Birmingham
Birmingham News Co., Birmingham
WDXE—FM—324 N. Fourth Ave., Birmingham
WBRC—FM—1727½ Second Ave., S. Birmingham ....G. P. Hamann
Gadsen Broadcasting Co., 108 Broad St., Gadsen
Fu tsville Times Co., Holmes & Greene Sts., Huntsville
WMOB—FM—458 Government St., Mobile ....Sanford Helt
Mobile Daily Newspapers, 304 Government St., Mobile
WALA—FM—106 St. Joseph St., Mobile ....R. B. Henley
G. W. Covington, Jr., 2 Montgomery St., Montgomery
WMGY—FM—2½ S. Perry St., Montgomery ....John Lamar
WSFA—FM—Jefferson Davis Hotel, Montgomery ....C. I. Shelkofsky

ARIZONA

Sun County Broadcasting Co., 74 E. Pierson St., Phoenix

ARKANSAS

Arkansas—Oklahoma Broadcasting Corp., Ward Hotel, Fort Smith
KFPW—FM—1213 Garrison Ave., Fort Smith ....J. M. Van Horn
KFSA—FM—505 Rogers Ave., Fort Smith
KWHN—FM—P. O. Box 799, Fort Smith. J. F. Darby
KUOA—FM—Siloam Springs.....K. D. Maxwell

CALIFORNIA

KONG—FM—1516 Oak St., Alameda
KERN—FM—17th & I St., Bakersfield..L. F. Shatto
KRE—FM—601 Ashby Ave., Berkeley 2
Beverly Hills Broadcasting Co., Beverly Hills
Big Bear Lake Broadcasting Co., Big Bear Lake
Burbank Broadcasters, 705 N. Lima St., Burbank
KHSL—FM—Morehead Bldg., Chico.....R. B. Pope
KIEM—FM—540 E. St., Eureka.....A. E. Sloon
Hollywood Community Radio Group, 1655 N. Cherokee St., Hollywood
KECA & ABC—FM—1440 N. Highland & 6285 Sunset Blvd., Hollywood
Leon Wyszatycki, 6028 Rita St., Hunting Park
W. R. Haupt, Inglewood
Cerritos Broadcasting Co., 2790 Chestnut Ave., Long Beach 6
Nichols & Warinner, Inc., 220 E. Anaheim St., Long Beach
Earl C. Anthony Inc., 141 N. Vermont Ave., Los Angeles
Cannon & Callister, Inc., 102 N. Glendale Ave., (Glendale)
KKLA—FM—1100 Glendale Blvd., Los Angeles 26 ....C. H. Haas
KMPC—FM—5939 Sunset Blvd., Los Angeles 28 ....L. C. Sigmon
KRKD—FM—312 Spring Arcade Bldg., Los Angeles 13....W. O. Freitag
Los Angeles Broadcasting Co., 645 S. Mariposa Ave., Los Angeles 5
Rogers & McDonald Newspapers, 2621 W. 54 St., Los Angeles
Standard Broadcasting Co., 338 S. Western Ave., Los Angeles
Unity Broadcasting Corp., of Calif. 116 W. 11th St., Los Angeles 15
KMYC—FM—519 E. St., Marysville, Calif. ....Loyd McQueary
Golden Empire Broadcasting Co., Box 717, Merced
KTRB—FM—P. O. Box 593, Modesto. W. H. Bates Jr.
KGO—FM—5433 E. 12th St. Oakland..A. E. Evans
Oakland Tribune, Tribune Tower, Oakland
Monterey Bay Broadcasting Co., 133 Middlefield Rd., Palo Alto
KPNI—FM—248 Hamilton Ave., Palo Alto
Rose Bowl Broadcasters Ltd., Pasadena
KVCV—FM—Redding.....R. B. Pope
FM Radio & Television Corp., 3654 Main St., Riverside
KXOA—FM—1617 30th St., Sacramento
KBMT—San Bernardino Sun & Telegram, San Bernardino
KSBR—FM—798 San Mateo Ave., San Bruno
KFSD—FM—326 Broadway, San Diego 21
Union Tribune Publishing Co., 941 Second Ave., San Diego 12
KGO—FM—155 Montgomery Ave., San Francisco ....A. E. Evans
KPO—FM—420 Taylor St., San Francisco 2 ....C. D. Peck
KSFH—FM—690 Market St., San Francisco ....W. T. Selsted
Pacific Agricultural Foundation, 87 E. San Antonio St., San Jose
Santa Clara Broadcasting Co., Bank of America Bldg., San Jose
KSMO—FM—811 B St., San Mateo....H. N. Black
KVSM—FM—279 Baldwin Ave., San Mateo ....M. F. Planting
Voice of the Orange Empire, Inc., 206 N. Main St., Santa Ana
KTMS—DelaGuerra Plaza, Santa Barbara
A. H. Croghan, 404 Georgina St., Santa Monica
Luther E. Gibson, 516 Marin St., Vallejo
KSYC—FM—Yreka

COLORADO

Rocky Mountain Broadcasting Co., 429 Thatcher Bldg., Pueblo

CONNECTICUT

Berkshire Broadcasting Corp., 7 West St., Danbury
Hartford Times, Inc., 10 Prospect St., Hartford
State Broadcasting Corp., 54 Pratt St., Hartford
WTHT—555 Asylum St., Hartford 3....C. S. Masin
WCLV—468 Center St., Meriden
Conn. Radio Foundation, Inc., Orange St., New Haven
WNHC—FM—1110 Chapel St., New Haven 10 ....Vincent DeLaurentis
WBRY—FM—61 Leavenworth St., Waterbury
Mattatuck Broadcasting Co., 182 Grand St., Waterbury

DELAWARE

Port Frere Broadcasting Co., New Castle County Wilmington
WDEL, Inc., 10th & King Sts., Wilmington
Wilmington Tri-State Broadcasting Co., Wilmington

WASHINGTON D. C.

WMAL—Evening Star Broadcasting Co., Star Bldg.
WQQW—FM—1743 G St., N. W.
WCFM—FM—2621 Virginia Ave., N. W.
Southern Broadcasters, Inc., 1922 Eye St., N. W.

FLORIDA

Seminole Broadcasting Co., P. O. Box 355, Bell Glade
W. Wright Esch, 432 S. Beach St., Daytona Beach
WNDB—FM—128 Orange Ave., Daytona Beach 1 ....Robert Saron
Gore Publishing Co., 231 S.E. First Ave., Ft. Lauderdale
WJAX—FM—Municipal Bldg., Jacksonville
WJHP—FM—500 Laura St., Jacksonville 1 ....Beecher Hayford
WGBS—FM—1605 Biscayne Blvd., Miami 36 ....H. A. Bondy
WWPB—FM—3810 Wood Ave., Miami
Hazlewood, Inc., Angebilt Hotel, Orlando
WHOO—FM—Fort Gatlin Hotel Bldg., Orlando ....S. A. Beck
Capital City Broadcasting Corp., Tallahassee
WDAE—FM—114 N. Franklin St., Tampa 1 ....W. P. Moore
WFLA—FM—Seminole Bldg., Tampa 2 J. M. Mitchell
WJNO—FM—1500 N. Flagler Drive, W. Palm Beach ....O. C. Wright

GEORGIA

WAMS—Messenger Publishing Co., Athens
WGAU—FM—Bobbin Mill Road, Athens ....W. J. Evans Jr
Constitution Publishing Co., 148 Alabama S.W., Atlanta
General Broadcasting Co., Georgian Terrace Hotel, Atlanta
WRDW—FM—8th & Broad Sts., Augusta
Voice of Augusta, Inc., 1008 S. Finance Bldg., Augusta
WGAA—FM—West Theatre Bldg., Cedartown ....C. F. Hooper
WDAK—FM—1028½ Broadway, Columbus..L. R. Jones
Dublin Broadcasting Co., Franklin & Moore St., Dublin
Macon Telegraph Publishing Co., 450 Cherry St., Macon
WMGA—FM—606 Fifth Ave., S.E., Moultrie
Atlantic Broadcasting Co., 17 Drayton St., Savannah
WCCP—FM—Georgia State Bank Bldg., Savannah ....W. E. Moats
WGOV—FM—East Park Ave., Valdosta...D. F. Ellis

ILLINOIS

Illinois-Alton Broadcasting Co., Alton
Copley Press, Inc., Aurora
WRGK—4221 Arthur Ave., Brookfield....G. M. Ives
WDWS—FM—49 Main St., Champaign
Chicago Federation of Labor, 666 Lake Shore Drive, Chicago
Drovers Journal Publishing Co., 836 Exchange Ave., Chicago 9
WENR—FM—20 N. Wacker Drive, Chicago 6 ....E. C. Horstman
UAW—CIO Broadcasting Corp. of Ill., 166 W. Washington Ave., Chicago
WLEY—FM—2526 N. Harlem Ave., Elmwood Park ....Paul Prokes
Sentinel Radio Corp., 2020 Ridge Ave., Evanston
WEBQ—FM—100 E. Poplar St., Harrisburg ....J. R. Tate
WMBD—FM—First National Bank Bldg., Peoria 2 ....A. J. Ebel
WQDI—130 S. Fifth St., Quincy
Lee Broadcasting Inc., 510 Main St., Quincy
Rockford Broadcasting Co., 109 S. Water St., Rockford

INDIANA

Trustees of Indiana University, Bloomington
WCSI—FM—Mode Theatre Bldg., Columbus ....Russ Newman
WCNB—406 Central Ave., Connersville
Journal Review, Crawfordsville
WTRC—FM—Elkhart.....L. W. Zellmer
Tri-State Broadcasting Corp., Evansville
Farnsworth Television & Radio Corp., 3700 E. Pontiac St., Fort Wayne
WJOB—FM—449 State St., Hammond ....Stanley Strasburg
WFAM—FM—Wallace Bldg., Lafayette 1. H. C. Garba
Chronicle Publishing Co., 610 S. Adams St., Marion
WSRK—FM—125 E. Washington St., Shelbyville ....H. J. Gorley
WBOW—FM—303 S. Sixth St., Terre Haute
WTHI—FM—313 Fairbanks Block, Terre Haute

IOWA

KCRG—FM—Cedar Rapids.....W. L. Babcock
WHO—FM—1002 Brady St., Davenport
KRNT—FM—715 Locust St., Des Moines
Independent Broadcasting Co., 500 Bankers Trust Bldg., Des Moines
KDTH—FM—Dubuque Telegraph-Herald, Dubuque
WDBQ—FM—505 Main St., Dubuque...John Veyoka
Lee Radio, Inc., 12 Second St., N.E., Macon City
Perkins Bros., 415 Douglas St., Sioux City
Josh Higgins Broadcasting Co., 500 E. Fourth St., Waterloo

KANSAS

KIMV—28 E. Second St., Hutchinson
KCKN Broadcasting Co., 901 N. Eighth St., Kansas City .....Max Williams
Sunflower Broadcasting System, 22 S. 18th St., Kansas City
The World Co., 722 Mass. St., Lawrence
KFBI—FM—200 E. First St., Wichita...K. W. Pyle

KENTUCKY

Ashland Broadcasting Co., 20th & Greenup Sts., Ashland
Bowling Green Broadcasting Co., 901 Fairview Ave., Bowling Green
WHOP—FM—Cadiz Road, Hopkinsville..L. Y. Wilson
WTNT—Kentucky Home Life Co., Louisville
WAVE—33a E. Broadway, Louisville....W. E. Hudson
WOMI—FM—Byars & Livermore, Owensboro ....Leslie Goodaker
Owensboro on the Air, Inc., 314 Allen St., Owensboro ....Earl Jagoe
WINW—FM—Wall & Cleveland Sts., Winchester

LOUISIANA

KALB—FM—505½ Johnson St., Alexandria ....Jesse Sexton
WLSU—FM—La. State University, Baton Rouge ....B. L. Gibson
Liner's Broadcasting Station, Inc., Jackson & Harrison, Monroe
WRCM—FM—1500 Canal St., New Orleans 12 ....G. A. Mayoral
WTPS—FM—615 Howard Ave., New Orleans 13 ....H. F. Wehrmann

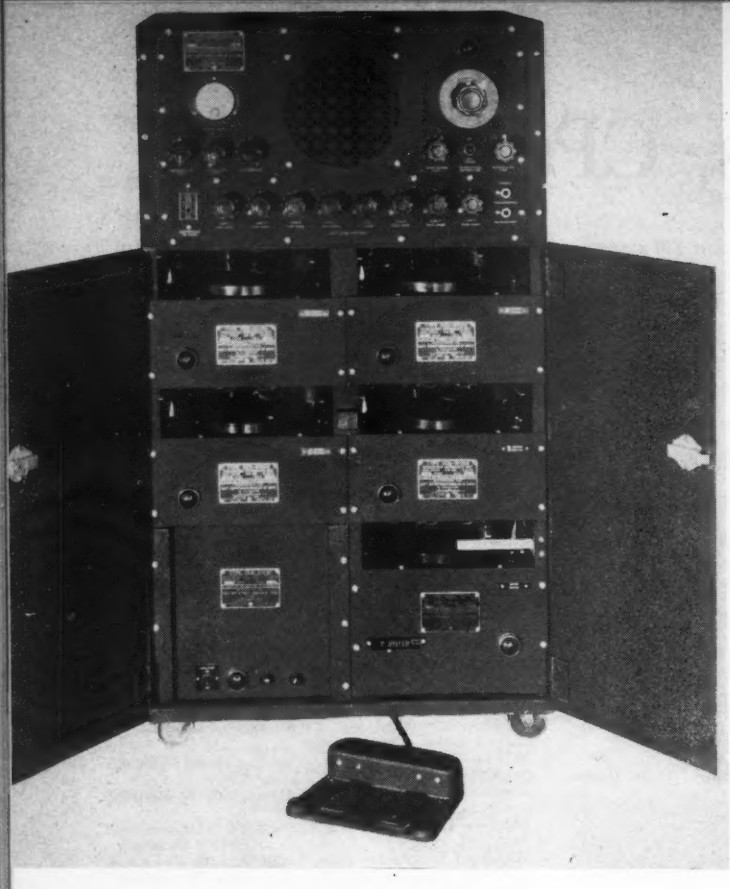
MAINE

WCOU—FM—223 Lisbon St., Lewiston. Donald Mason

MARYLAND

Capital Broadcasting Co., Annapolis
Baltimore Broadcasting Co., North Ave. & Harford Ave., Baltimore 13
WASA—Baltimore & Charles Sts., Baltimore

(*Continued on page 121*)



Technics of Sound Methods

By LINCOLN THOMPSON, Sound Scriber Corp., New Haven, Conn.

Fig. 1—Navy model recording equipment, designed to permit use of 330 grooves per inch and at 22 rpm giving recording time of one-half hour on each side of a seven-inch disc

• In all sound recording processes the frequency response which can be recorded is limited by the relation between sound track speed and the dimensions of the styli or other equivalent elements which register and reproduce the sound modulations. In the case of the mechanically recorded disc, the recording and playback styli are the elements which register the sound modulation, while in photographic and magnetic recorders the light beam slit and the magnetizing poles are the stylus equivalents.

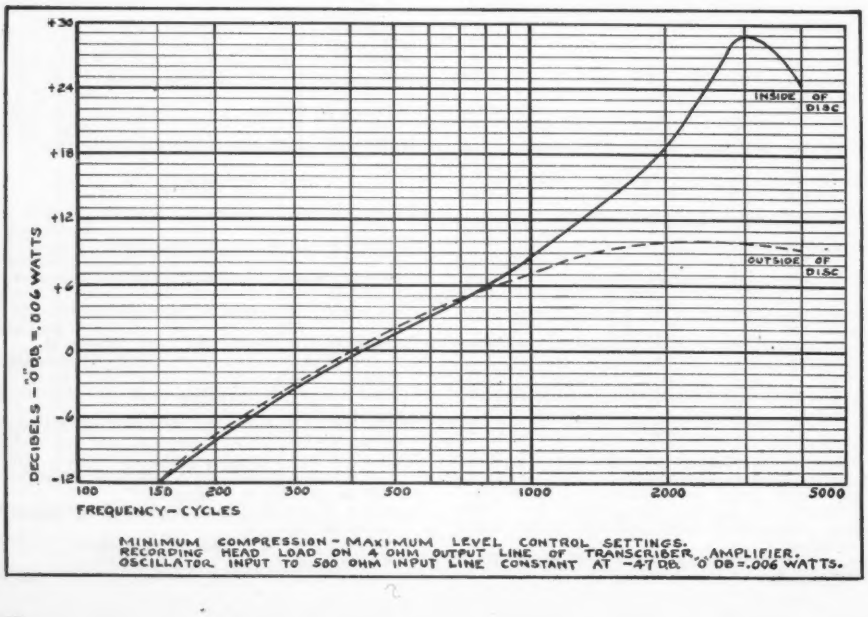
It is well known that a calculation of the recorded frequency response of a photographic recording can be made from the width of the photographic recording slit and the track speed. The slit width which is equal to one-half a wave length is the practical top limit for the highest frequency recordable. The same simple formula applies to the reproducing slit in the photoelectric playback equipment. Consequently, a photographic system is susceptible of simple prediction as to the response limitations for a given track speed. This can be used as a basis to predict the best compensating response curves for the recording and reproducing amplifiers.

In other recording methods, the same general principles apply but there are other complicating factors which make predictions and calculations more complex. A great deal of work has been done on disc recording of the conventional cut groove type and also with magnetic recording. Considerable frequency compensation is usually made in all systems. From purely mechanical considerations, however, mechanically - grooved disc records of the cut type and of the embossed type vary considerably.

With the cut groove, the keen-edged recording stylus is capable in itself of registering very high frequencies at low track speeds with considerable amplitude. These amplitudes can be far in excess of the ability of the rounded-tip playback stylus to follow and reproduce at their full value and, in addition, the "pinch" effect comes into the reproduction process.

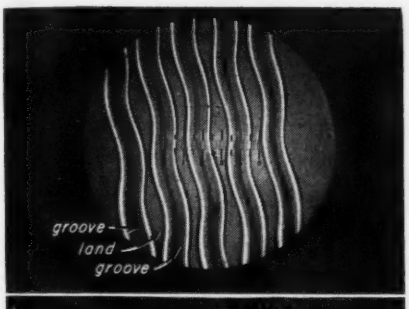
By comparison, the mechanically-embossed groove is created with a blunt stylus and at equivalent track speeds of a low order the embossing stylus tends merely to widen the groove rather than to modulate it at the higher frequencies. Interestingly enough, however, for very low amplitudes the fact that the round edge is in a tangential line contact with the groove edge makes possible the registration of high frequencies at low track speeds to a degree not usually recognized. The amplitude permitted without groove widening effects is smaller and smaller

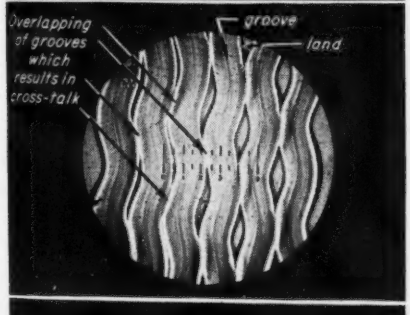
Fig. 2—Typical frequency response of recorder amplifier



Recording with Embossed Groove

Engineering involved in providing for good frequency response, long playing time and proper groove formation — Design of pick-up heads





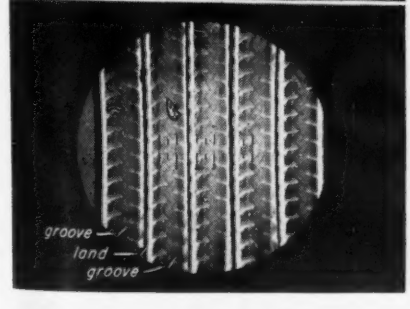


Fig. 3—Typical photo of 400 cycles recorded at normal sound level. Fig. 4—A 400-cycle recording at a level beyond maximum allowable, resulting in evidence of cross-talk. Fig. 5—Photo of microscopic enlargement of record showing grooves made at normal sound level by a 2000-cycle note

the higher the frequency being recorded and finally reaches a value where, in reproduction, its low level will be lost in the inherent surface noise of the recording medium.

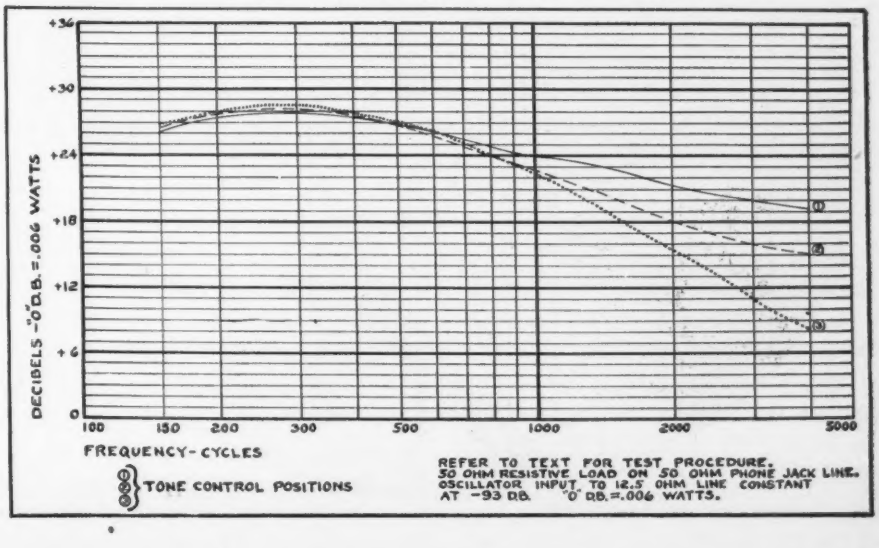
Great progress has been made with cut groove recording and reproduction because the entertainment field has demanded the best in fidelity and has been a volume field. The combination of playback mechanisms permitting vibratory vertical movement and playback styli to play the "pinched" cut grooves which result from high amplitudes is well known. A corresponding degree of general attention has not been given the embossed groove, probably because of the more limited application.

The importance of the embossed groove record in business recording makes the study of this whole process of considerable interest. This is particularly true since it is not expected that the frequency response should equal that generally required for the entertainment uses of sound recording. Moreover, low track speeds and long playing time are necessary to achieve the economy and convenience that business recording requires.

The embossed groove record has many advantages over the cut groove where recorders are to be used by unskilled people. The curling chip, characteristic of the cut groove, makes this type of disc recording impractical for most business use unless the record is of soft wax where the chips are more or less easily disposable. A multi-groove record, such as a cylinder, a short belt, or a disc, alone provides the easy place-finding required for convenient business use.

The fact that magnetic recording on a multi-track medium, such as a disc or belt, demands wide spacing between adjacent sound tracks, greatly limits its usefulness for general business purposes. The further fact that the recording is not visible on the medium is another drawback in the use of the magnetic method for any business process. The easy place-finding on a disc with an embossed groove, plus the reasonably good fidelity, plus the ease of filing, mailing and handling, make an embossed groove disc ideal for the business dictation process, provided low recording cost is achieved. This low

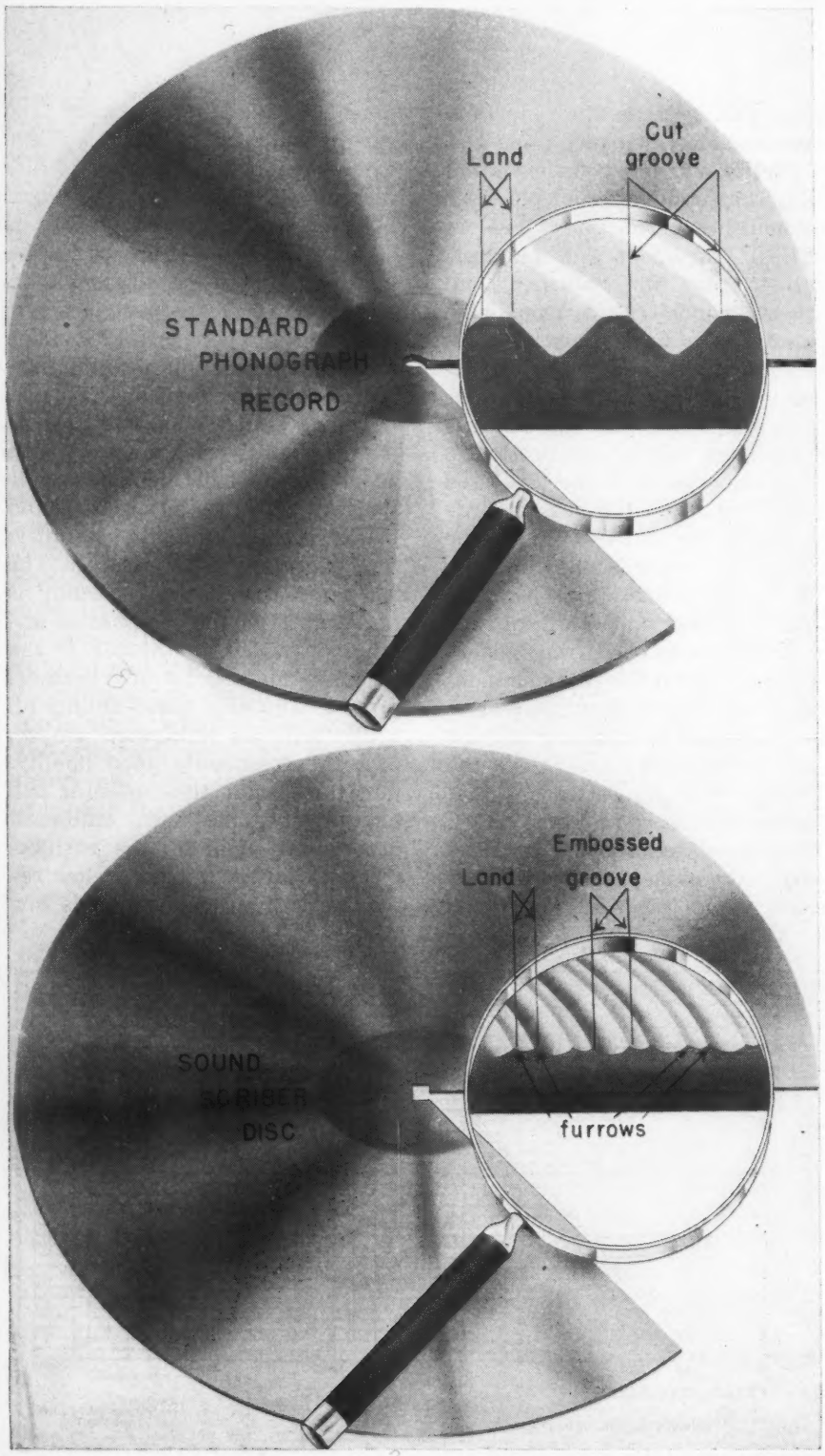
Fig. 6—Typical frequency response of reproducer amplifier



cost is accomplished by achieving long playing time on a thin inexpensive disc.

In business use, convenience and easy transcribability by the typist are also at a premium in order to make the process efficient. Clarity of the recording and reproduction is basic to the entire process and of price importance even though high fidelity may not be necessary. This calls for a frequency range of at least 200-3000 cycles with as wide a volume range as possible, together with the slow track speed of the long playing record. The better this fidelity the easier the typist's job. Standard SoundScriber machines operate at 33 rpm and 220 grooves per inch and give fifteen minutes of recording on each side of a seven-inch disc. The five-inch disc gives seven and one-half minutes of recording on each side, thus allowing for two convenient record lengths for dictation processes and retaining the convenience of discs which are easily handled, may be filed or sent through the mails at very low cost.

Fig. 7—Drawing arranged to show a comparison between the grooves cut in a standard phonograph record and the embossed grooves produced with SoundScriber equipment



During the war the Navy required recorders with playing time longer than 15 minutes and called for extended playing time on discs which retained the same easy-handling features and the simple, trouble-free constant angular velocity design. This necessitated many refinements. The requirement for one of the Navy models (Fig. 1), which became standard at all Naval Air Stations and was put aboard many carriers, was that each disc should play one half hour on each side of the seven inch disc. This playing time was attained by the use of 330 grooves per inch and 22 rpm on the same 7 in. disc.

Track Speed Studies

The Navy frequency response requirement called for a range of 200-3000 cycles throughout the disc. In order to meet the frequency response and retain good volume range, special technics were required since the track speed dropped to 16 ft. per minute at the inner record circles. To produce this result a complete study was carried out as to the relationships of track speed, maximum recording equalization permitted at 3000 cycles without groove widening, and the signal-to-noise ratio which could be achieved.

This required development of a technic of photographing the projection of the modulated groove with a magnification of about 500 times. Transparent recording discs were used and the projected and magnified image through the disc was photographed. Fig. 3 shows a typical photograph of 400 cycles recorded at normal sound level and a groove speed of about three inches per second. A series of these photographs at different frequencies was made. As a result of this study the normal pre-emphasis of high frequencies used in record-

ing was finally varied continuously throughout the record, reaching a maximum in the inner record grooves.

The amplifier equalization (Fig. 2) finally adopted after considerable fundamental study was 26 db. at 3000 cycles at the inner circles and required an 8-watt amplifier to avoid amplifier overload by these accentuated high frequencies. To achieve the widest possible volume range, full modulation of the closely-spaced grooves was required but the limitation in modulation was the cross-talk which occurred at high amplitudes. This meant that the width of the groove and the spacing between grooves had to be controlled within accurate limits.

Fig. 4 shows a 400-cycle recording at a level beyond the maximum allowable and resulting in cross talk. The groove had to be large enough for good tracking and narrow enough for the maximum possible "land" between groove edges.

A few of the long series made are shown in Figs. 3, 4 and 5 which illustrate graphically how higher frequencies cause the groove to widen at very slow speeds and high recording level and leave only the slight modulation ripples on the side of the groove. When this widening effect begins, the recorded result is non-linear and the voltage generated by the reproducing pickup actually decreases in the grooves where the input to the recording head had increased. Also, the playback arm fails to track these widened grooves adequately and reproduction further suffers on this score. However, by providing a fairly sharp cut-off above 3000 cycles much of the resulting distortion harmonics is effectively eliminated.

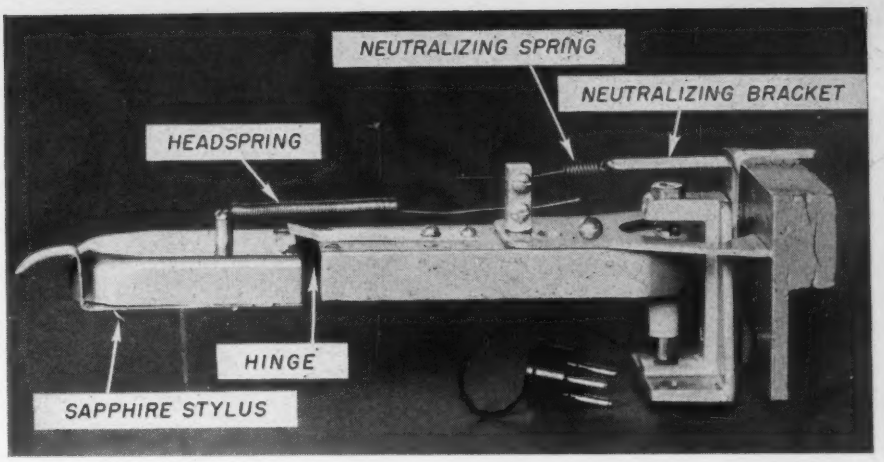


Fig. 8—Side view of SoundScriber playback arm with important parts identified

The recorded amplitude permitted without groove widening at these slow track speeds must be such as to give a level well above the surface noise of the disc itself. The reproducing response can be set to attenuate the high frequencies in order to lower the surface noise since the surface noise is more concentrated in the higher frequencies. However, the specified frequency range limits the degree of high frequency attenuation in reproduction and limits the surface noise reduction by this means. Therefore, a nice compromise between all of these factors was necessary. Thus, for the given record material, with given surface noise, it was a matter of a compromise between the amount of recording equalization which can safely be used without groove enlargement and the particular playback response curve to be used. The amplifier playback and recording curves are shown in Figs. 2 and 6.

The amplifier playback curve not only complements the recording amplifier curve but, in addition, takes into account the fact that there is inherent loss in the playback process due to the dimensions of the playback stylus itself as well as the fact that there is a deliberately peaked high frequency response in the recording head. Overall response curves are shown in Fig. 2.

The fact that for low recorded amplitudes the extreme edge of both the recording and playback styli are in line contact with the groove edge gives far better high frequency response at low levels than would be expected. This makes the surface noise of the recording material the real limitation to frequency response and volume of an embossed groove process.

Again, comparing the process to photographic recording, for small amplitudes the recording stylus edge acts like a very narrow photographic slit while for larger am-

(*Continued on page* 113)

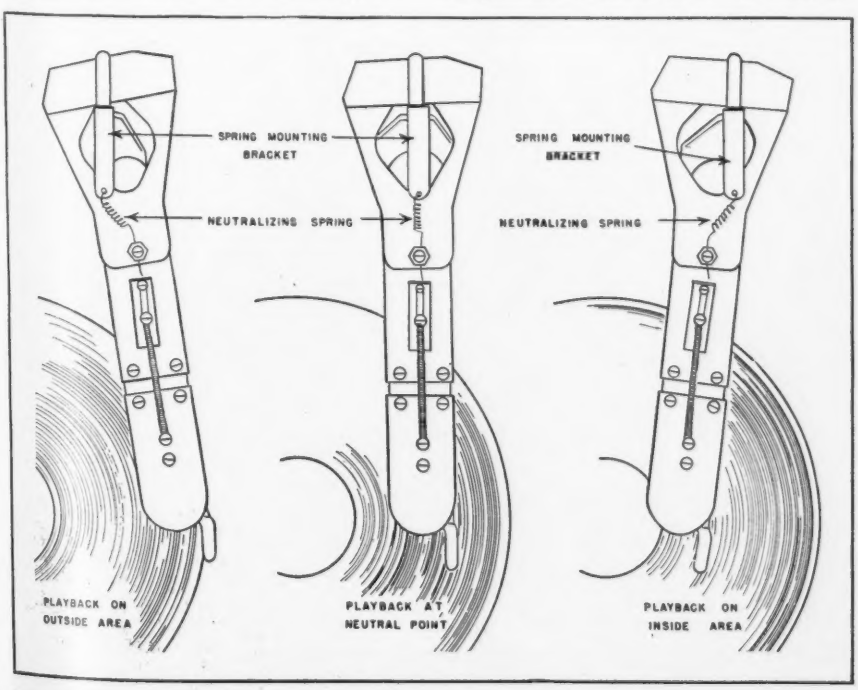


Fig. 9—Three views showing the position of the neutralizing spring for three positions of the playback arm

To give the press a pre-view of IRE's 1947 National Convention, these engineers addressed a luncheon on the day of the opening (left to right): J. M. Moorhead, NEMA; Virgil M. Graham, Sylvania Electric Products Co.; James E. Shepherd, General Chairman of the Convention, Sperry Gyroscope Co.; Dr. W. R. G. Baker, new IRE President, General Electric Co.; George W. Bailey, Executive Secretary IRE; Dr F. B. Llewellyn, past president IRE, Bell Telephone Labs; Ernst Weber, Chairman of Convention Technical Program, Brooklyn Polytechnic Institute; and Clinton B. DeSoto, Technical Editor Proceedings of IRE

IRE Reveals Engineering Advances

35th anniversary "Electronics at Peace" gathering attracts 12,549 members and guests to hear 125 technical papers and see radio engineering show

• The 1947 National Convention of the Institute of Radio Engineers was big—far bigger than all previous annual gatherings that have gone before it. For four days and nights 12,549 members and guests jampacked the Hotel Commodore in New York and the aisles and exhibits and auditoriums in Grand Central Palace which housed the Radio Engineering Show. Over 1400 sat down for the annual dinner, and when the meetings wound up their final sessions on March 6, members had heard some 125 technical addresses spread over 25 categories to include every phase of radio communications and the application of vacuum tube equipment to industrial processes. It was the 35th anniversary of the founding of IRE. Convention theme was "Electronics at Peace".

President W. R. G. Baker emphasized that theme when he told members and guests at the annual dinner: "It is the business of the scientist to find the fundamental means for the mastery of nature. It is the responsibility of the engineer to make these truths of use to mankind". Guest speaker Charles R. Denny, Chairman of

IRE's new president, Dr. W. R. G. Baker; Dr. Daniel E. Noble, Motorola Vice President, and FCC's Chairman Charles R. Denny, at Fellowship awards during annual banquet

FCC, put it another way. He said: "We wait with keen anticipation the important contribution which your profession will make in the years ahead".

Not the least impressive feature of the dinner was the annual award of IRE honors. To Dr. Albert Rose of RCA Laboratories went the 1946 Morris Liebman memorial prize for his work on the development of the Image-orthicon tube; the Liebman prize for 1947 went to Dr. John Robinson Pierce of Bell Telephone Laboratories who developed the traveling wave tube; to Dr. Charles L. Dolph, of the University of Michigan, went the Thompson award.

Advanced to Fellowship in IRE were these 25 members: George P. Adair, Chief Engineer FCC; Benjamin de F. Bayley, Univ. of Toronto; George L. Beers, RCA Labs; Lloyd V. Berkner, Joint Research and Development Labs; Edward L. Bowles, M.I.T.; Robert S. Burnap, RCA; Robert F. Field, General Radio Co.; Donald G. Fink, McGraw Hill Pub. Co.; William H. Hansen, Stanford Univ.; David R. Hull, BuShips, U.S. Navy; Fred V. Hunt, Cruft Lab; Karl K. Jansky, Bell Telephone Lab; Ray D. Kell, RCA Labs; Charles V. Litton, Litton Eng. Labs; James W. McRae, Bell Telephone Lab; Ilia A. Mouromtseff, Westinghouse; Dr. Daniel E. Noble, Galvin Corp.; Pedro J. Noizeaux, Transradio Internacional; Robert M. Page, Naval Research Labs; John A. Pierce, Cruft Lab; Frank H. R. Pounsett, Stromberg-Carlson of Canada; Conan A. Priest, GE; Winfield W. Salisbury, Collins Radio; Robert Watson-Watt, Sylvania; Edward N. Wendell, Federal Tel. and Radio Corp.

Technical Topics That Held the Interest of Engineers

CARRIER CURRENT

Imre Molnar
Automatic Electric Co., Chicago, Ill.

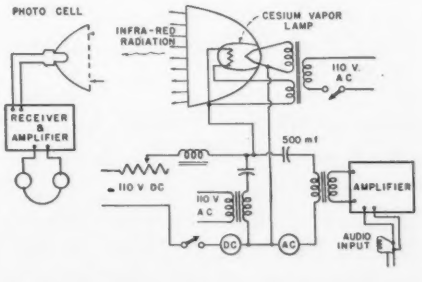
By using suppressed carrier, the Automatic Electric Co. and the Lenkurt Electric Co. jointly developed a telephone system suitable for automatic operation. Connections are established and dial pulses extended through the carrier associated with the voice transmission channel. With single sideband transmission and very sharp bandpass filters in the speech channels, residual carrier leak at the modulator output can be reduced to a negligible quantity. Due to this feature, together with high oscillator stability, the carrier frequency and the available gap between two adjacent carrier speech channels can now be used for independent signal transmission, without interfering with or being interfered with by its associated speech channel. A carrier telephone circuit is equivalent to a four-wire transmission channel because the sidebands in each direction are derived from two widely separated carrier frequencies; therefore full duplex signaling is automatically provided by using each carrier in its respective direction.

The described carrier system is suitable for any type of telephone system operation: between manual toll centers; between a toll center and remote automatic network; or between several distant automatic exchanges, where the subscribers themselves build up the connection by dialing, without the intermediary of an operator. It can be used over physical wire lines, or superimposed over a radio transmission system.

INFRARED COMMUNICATIONS

M. C. Beese
Westinghouse Electric Corp., Bloomfield, N. J.

An infrared communication system with particular use in fields where high secrecy is desired as in the military has been designed by Westinghouse. Advantages of infrared communication are, (1) No eaves-dropping or jamming; (2) No frequency stabilization;



(3) Comparatively simple inexpensive equipment. The disadvantages are that it does not operate in fog or bad weather and the range is limited to about eight miles.

Westinghouse developed a caesium lamp for generation of infrared rays and capable of easy modulation. Modulation frequencies up to 5,000 cps were possible with fair reproduction; beyond that the sensitivity dropped off sharply. The caesium vapor lamp formed the modulated source of a searchlight beam transmitter.

PARTICLE ACCELERATORS

G. W. Dunlap
General Electric Co., Schenectady, N. Y.

Accelerators being planned and used and how they all fit in nuclear studies include "straight" accelerators where the charged particle is accelerated by its falling through a single potential across the entire tube; "multiple" accelerators in which successive accelerations would take place through a series of gaps arranged in a straight line; and "circular" accelerators characterized by large electromagnets which hold the particles to circular paths while they are accelerated to very high energies.

The hetratron utilizes an ac magnet with a donut shaped vacuum tube as the accelerating chamber. Electrons injected into the tube at the instant of zero magnetic flux are accelerated by transformer action of the changing flux while they are held in a circular path by a portion of the same flux. When the desired energy has been reached they are caused to strike a target to produce a beam of X-rays.

IONOSPHERIC CLOUDS

H. G. Wells
Carnegie Institute of Washington, D. C.

Storms of severe intensity in the ionosphere are electrical disturbances coming from the sun. Radio waves provide our only consistent means of exploring and studying the ionosphere although the use of rockets offers considerable promise for specific measurements. The

rarified gases which constitute our outer atmosphere — where the pressure is less than within a vacuum tube — are ionized by the Sun's radiation. The ions and electrons thus formed are capable of bending or refracting radio waves. Exploring radio waves are utilized to measure density or concentration or ionization as well as heights of the several gaseous layers.

A description of a motion-picture recording technic applied to a new-type ionospheric apparatus reveals startling and hitherto-unsuspected rapid motions and fluctuations in the ionosphere. This Panoramic Ionospheric Recorder operates over a frequency-range from approximately 1 to 20 mc. The Breit-Tuve pulse system is used and time intervals between transmitted pulses and ionospheric echoes are recorded on a cathode-ray screen. Sweep time for this frequency-range is 15 seconds. The recording camera is controlled to open a shutter at the start of the sweep and to close the shutter at end of sweep. A separate frame of 16 mm film is exposed for each sweep. The sequence is repeated twice each minute, and the finished record is projected as a motion picture. At standard projector speed of 16 frames per second, one observes eight minutes of ionospheric recordings each second.

CRYSTAL NETWORKS

L. Apker, E. Taft and J. Dickey
General Electric Co., Schenectady, N. Y.

This discusses the effect, called reciprocity failure, where the insertion loss of a non-linear four-pole is not the same for power transmitted in opposite directions. The results of tests on twenty crystals (silicon and germanium) which were tested as converters by double-heterodyne methods were presented.

TETRODES VS TRIODES

W. G. Wagener
Eitel-McCullough, Inc., San Bruno, Calif.

Neutralized tetrodes offer higher gain and greater circuit stability over neutralized triodes operating in the 500 mc region. Eimac engineers, declaring inadequate the conventional tube circuit equivalent diagrams, devised a new approach accounting for stray tube parameters hitherto considered insignificant. Feedback voltage from plate-to-grid is 2 volts per mc for new Eimac tetrode; as much as 10 volts per mc for conventional triodes.

LINEAR ACCELERATORS

J. C. Slater
M.I.T., Cambridge, Mass.

The discussion was extended in the case of linear accelerators by a description of how a high intensity electromagnetic wave reaches a velocity equal to that of the particles to be accelerated by a longitudinal electric field in a waveguide. A particle in the correct phase will then continually gain energy, as if it were in a uniform field, without having large voltages anywhere within the system. Electron accelerators operating in the microwave range are under construction at M.I.T. and at a number of other institutions; a positive ion accelerator operating at a lower frequency is being built at the University of California.

TROPOSPHERIC RECEPTION

G. W. Pickard and H. T. Stetson

Standardized measurements of field strengths from W2XMN's 42.8 mc FM transmitter, recorded daily over a two year interval, showed variations in reception that are dependent upon the passage of warm and cold fronts across the transmission path. Reception at a distance of 167 miles has been on the average three to four times stronger in summer than in winter. Data on these tests were analyzed in this paper.

WIRING TECHNICS

Cledo Brunetti
Nat'l. Bureau of Standards, Washington, D. C.

A review of the methods of applying radio and electronic circuits to small plates or cylindrical surfaces was described. The principal method employs silver and carbon inks or paints applied through stencils. Variations include hand painting or spraying. Other methods utilize photochemistry, chemical reduction, an abrasive blast, printing in vacuum chambers or punch press production.

The processes result in miniature circuits and afford substantial economics in manufacture.

SNOW STATIC

Willard H. Bennett
Nat'l. Bureau of Standards, Washington, D. C.

Research revealing some characteristics of snow static on aircraft was described. The properties of a device used for putting a charge on the airplane in flight were studied.

LOW FREQUENCY LORAN

Carson, Seaton, Rothman, Pomerantz
Watson Laboratories, Red Bank, N. J.

Three aspects of the LF Loran-Canada research program to date are the technical details of equipment, discussion of the research organization and examples of analytic and statistical results obtained to date.

The advantage of LF Loran at 180 kc as compared with standard frequency Loran at about 1800 kc comes largely from the difference in propagation phenomena in these two frequency ranges. For example, groundwave attenuation is much lower at the lower frequency. Skywave propagation at the low frequency is entirely E-layer reflected whereas the F-layers play an important and often confusing role in the region of 1800 kc.

PORTABLE BEAM RADIO

C. E. Sharp
Coles Signal Lab., Red Bank, N. J.

These beam radio sets relay communications across obstacles where it may be impossible or costly for troops to lay or maintain a telephone wire circuit. The requirements were privacy of conversations, no interference, lightweight, and simplicity in operation. The appearance of these sets is similar to a medium size searchlight mounted on a tripod.

3 CM RESONANT CAVITY

R. R. Reed
Westinghouse Electric Corp.

In the summer of 1944 Westinghouse undertook the development of a resonant cavity for use in the automatic frequency control circuit for the beacon local oscillator. This was to be a transmission type cavity whose resonant frequency would be nearly independent of temperature and humidity effects and would be accurately pretuned at the factory.

It was decided to compensate this device for frequency shift due to temperature rather than construct it of a material with low coefficient of expansion. The "nosed-in" type of cavity was chosen as being readily formed and simply temperature compensated.

The coupling of source and load to the cavity was accomplished by means of Kovarglass windows inserted in the cylindrical walls of the cavity 180° apart. These windows are so designed as to withstand ambient temperatures from −40°C to 100°C.

The temperature compensation was accomplished by rigidly attaching the "nose" to the outer walls by means of metals having widely different temperature coefficients of expansion i.e., copper and invar. This is done external to the resonant part of the cavity which is closed at the "nose" end by a flexible diaphragm. Use of this length of copper and invar causes the protrusion of the nose to change with any temperature shift. By proper selection of this length the change will be such that the effect of the expansion (or contraction) of the cavity in changing its resonant frequency will be approximately compensated.

FEED-BACK AMPLIFIERS

J. A. Rado, A. M. Levine, M. G. Hollabaugh
Federal Telecommunication Laboratories
Newark, N. J.

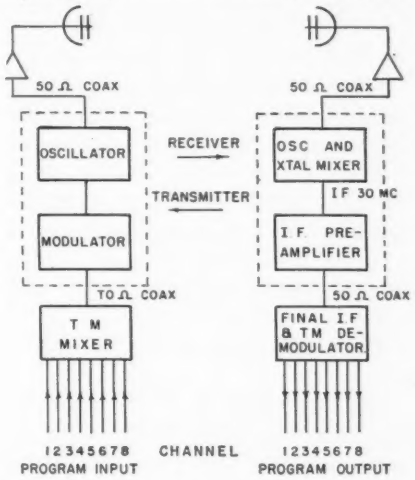
In the realm of color television and pulse modulation systems one encounters the need for much wider bands in the range from 10 to 50 mc where it is necessary to exploit as fully as possible the capabilities of components in order to realize a practical result. In using inverse feedback, adjustments need be made only on the terminating filter of the whole amplifier and the performance of a feedback amplifier approaches more closely the theoretical criterion as the number of stages is increased. Other advantages arise out of the use of feedback such as the reduction of disorder due to non-linearity. Analysis of the generalized feedback amplifier reveals that it is a ladder network with negative conductance shunt arms. This is the function of the amplifier transconductance which is a negative quality. A mathematical analysis established that these amplifiers have a gain-bandwidth capacity equal to that of an ideal amplifier. In actual amplifiers the ideal has been approached very closely.

Using 6AK5 tubes, amplifiers have been constructed having video bandwidth of 13mc and 20 mc. In these amplifiers simple terminations were used consisting of the characteristic resistance of the network in series with a peaking inductor.

MULTIPLEX BROADCASTING

A. M. Levine
Federal Telecommunications Laboratories

A system using time division multiplexing and pulse-time modulation has been developed and may be used for broadcasting high-fidelity low-noise programs in the UHF region. A laboratory prototype simultaneously transmits eight programs of 9500 cycles each



over a single rf carrier frequency at 930 mc.

The eight programs are fed to a time modulation mixer and converted to pulses of approximately one-half microsecond width. This pulse energy allows large bursts of energy to be transmitted for short periods of time; hence the average radiated power is comparatively small. At the receiver, the signal is fed to a PTM demodulator and separated into the original eight programs. Program selection may be accomplished by pushbutton switching.

TWO TUNED CIRCUITS

S. H. Chang
Watson Laboratories, Cambridge, Mass.

The reciprocal of system response function, $\frac{E1}{E2}$, of conventional two-mesh tuned coupled circuits, when plotted in the complex plane, will give a parabolic locus under certain restrictions.

Many well-known properties of the coupled circuits can thus be deduced from the simple and familiar geometrical properties of the parabola.

For the application in design work, in order to meet the variation in different parameters, such as (a) the tightness of coupling, (b) the ratio of the Q's of the primary and secondary and (c) the amount of detuning, a complex set of parabolas of different focal lengths but with common vertex is drawn. By choice of the proper parabola and the corresponding origin, the system response function and its phase angle can be read directly from the polar radius and the corresponding angle. The frequency can be obtained from the readings on the j-axis with suitable conversion of scale.

The procedure of getting the reciprocal of system response function $\frac{E1}{E2}$ /g from a set of parabolic plottings may be summarized as follows:

1) Choose the parabola with the proper focal length and determine the location of the origin from the given data of the coupled circuits.

2) A transparent polar coordinate paper or cellulose sheet can be put over the parabola with the center set at the chosen origin. S and θ can then be read directly on the parabola with the aid of a rotating bar pivoted at the center.

(3) The frequency is proportional to the scale of j-axis.

(4) If the coupled circuits are cascaded by isolating vacuum tubes the magnitude of the overall response can be obtained by adding the ratio of $\frac{E1}{E2}$ expressed in db. The angle can also be read directly.

NETWORK DISTORTION

Dr. M. J. Di Toro
Polytechnic Inst. of Brooklyn (N.Y.)

All practical communication networks exhibit distortion from the ideal of linear phase and flat amplitude frequency response characteristics. A good test to determine the extent of such distortion comprises the determination of the transient response of the network to a step (Heaviside) signal.

Networks with excessive phase distortion show considerable tendency to overshoot and "ring" when excited by a step wave and, to an even greater extent, when excited by an impulse function. In applications like television and telepho-

tography this is serious. It may be avoided by phase-correcting networks by making the amplitude bandwidth of the network much smaller than the phase bandwidth.

Design data were shown for performance determination of delay lines with lumped and distributed parameters, of a stagger-tuned IF amplifier, and of a series-peaking coil video amplifier comprising a large number of cascaded sections. Curves were shown that reduce the amount of time and effort required for studying transient response.

HELICAL-WAVE PROPERTIES

C. C. Cutler
Bell Telephone Laboratories

Experimental determinations of the electric field distribution inside a helix used in a traveling wave tube were made by means of a small probe and a neon bulb. The longitudinal electrical field component along the axis which is of particular interest is stronger than predicted by the theory.

FREQUENCY RESPONSE

Reuben Lee
Westinghouse Electric Corp.

If a network has to pass a square wave of so many microseconds duration with "reasonable" distortion, it is stated that the network must "pass" all frequencies below an arbitrary limit. What constitutes reasonable distortion, as well as what constitutes passing a frequency, are matters which an engineer decides by experience. It is with the more accurate evaluation of these criteria that this paper is concerned.

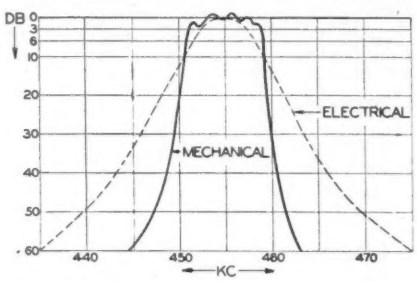
A network must have at least 90% of maximum response at a frequency 1/30th of the reciprocal of the pulse width in order to keep the top of the pulse within 90% of maximum amplitude throughout the entire pulse width. This is true for the most common types of network, whether used singly or in several successive stages of amplification.

At the higher frequencies, the optimum wave shape obtains when there is approximately 1% overshoot at the front of the wave. Under these conditions, the frequency at which the response is 90% of maximum must be 1/4 to 1/2 the reciprocal of the time required for the front of the pulse to attain 90% of maximum amplitude, the figure of 1/4 to 1/2 depending on the circuit.

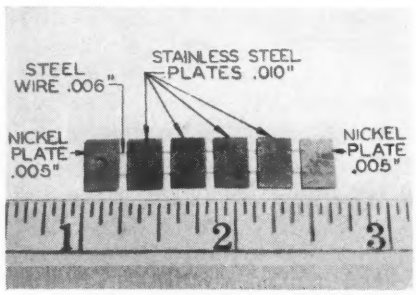
MECHANICAL FILTER

Robert Adler
Zenith Radio Corp., Chicago

A novel and rather unconventional wave filter which is suitable for the IF channel of broadcast and communications receivers has been designed. Its frequency response is characterized by a flat pass-band and by extremely rapid attenuation outside the band limits. Its adjacent-channel selectivity surpasses that obtained with much more expensive conventional filters.



The new filter is of the electro-mechanical type. Intermediate frequency currents, upon entering the filter, are converted into mechanical vibrations of the frequency. These vibrations are then made to pass through a structure resembling a ladder, consisting of several mechanically resonant metal plates coupled to each other by means of wires which act as springs. This structure forms a band-pass filter for mechanical vibrations. The filter is said to be stable, economical, and extremely compact.



SMALL ANTENNAS

Harold A. Wheeler
Great Neck, N. Y.

The practical efficiency of a capacitor or inductor operating as a small antenna is limited by the "radiation power factor" of the antenna as compared with the power factor and bandwidth of the antenna tuning. The radiation power factor of either kind of antenna depends on the cylindrical volume occupied by the antenna divided by its radian-length at the operating frequency. The efficiency is further limited by the closeness of coupling of the antenna with its tuner. Simple formulas were given for the more fundamental properties of small antennas and their behavior in a simple circuit.

SEARCH RADARS

F. A. Darwin
Hazeltine Electronics, Little Neck, N. Y.

Pulse transpondor systems, their uses and the parts which make them up were described. The similarity of one of the parts, (the interrogator) to a search radar was pointed out. Various methods of accomplishing both search and interrogation were analyzed. The steps to be taken to make a good radar capable of quasi-simultaneous operation as good interrogation equipment for a system with adequate traffic-handling capacity are outlined briefly. For maximum performance and reliability, with minimum cost and complexity of equipment, radars are best used as radars, with separate interrogation equipments used in transpondor systems, operated servile to such radars where cooperative operation is desired.

PULSE MODULATION

S. Moskowitz and D. D. Grieg
Federal Telecommunication Laboratories
Newark, N. J.

Time modulation offers an improvement in signal-to-noise ratio over that obtained by amplitude modulation of either continuous or pulsed waves. The improvement is proportional to the radio frequency bandwidth used in the transmission link. In terms of the pulses, the improvement is proportional to the time modulation displacement and inversely proportional to the buildup or decay whichever is the smaller.

A main measure of protection against noise interference offered by time modulated pulses is due to the high ratio of peak-to-average power. The threshold of improvement is reached when the peak pulse amplitude is about twice the effective noise peaks. Hence, devices such as limiters

may be used to considerable advantage.

The greatest degree of noise suppression is obtained when successive stages of limiting and differentiation are incorporated in the receiver. Noise entering by amplitude modulation of the pulses and between the pulses may be removed by proper limiting providing the input signal to noise ratio is greater than 6 db. Following this stage, a differentiator serves to extract the proper pulse edge thus removing width modulation noise. Successive stages of limiting and differentiation may follow. These operations may also be obtained by the action of a multivibrator.

Noise entering by displacement in time of the leading or trailing edge of the pulse is of the same form as the modulating signal and is inherent in the system of modulation. However, the noise displacement may be reduced by decreasing the buildup or decay time of the pulses; i.e., increasing the bandwidth of the system.

BANDWIDTH RELATIONS

H. Busignies and M. Dishal
Federal Telecommunication Laboratories
Newark, N. J.

It is pointed out that information is transmitted and received at a very slow rate (electronically speaking) in most navigation and direction finding systems. Because of this slow rate of transmission of intelligence, quite small bandwidths (probably of the order of only 10 to 100 cycles) are actually required to satisfactorily reproduce the intelligence. The point is made that navigation systems should thus use simple modulation shapes to convey the desired intelligence so that bandwidth is not wasted.

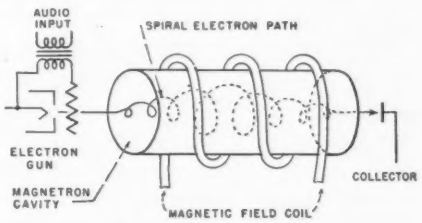
In considering the relations between bandwidth and signal to noise ratio, narrowing the passband before final detection is compared with bandwidth narrowing after final detection. It is shown if large signal-to-noise ratios are always to be used, narrowing the bandwidth either before or after final detection gives essentially the same results. However, for the important case of small signal-to-noise ratios (e.g., 3 to 1), it is shown that for pre-detection narrowing the signal required for a given signal-to-noise ratio is proportional to the square root of the bandwidth ratio, whereas for post-detection narrowing, the signal required for a given signal-to-noise ratio is proportional to the 4th root of the bandwidth ratio.

A possible new method of reception is described which may allow signals to be reproduced at extremely low signal to impulse noise ratios. This system utilizes the bucking detector scheme and measures the resultant impulse noise which is dependent upon the signal input when carrier and impulse are simultaneously present.

MODULATED MAGNETRONS

L. P. Smith, J. Kurshan and J. S. Donal
RCA Laboratories, Princeton, N. J.

Converted from its wartime application of generating pulsed and continuous waves for radar, the magnetron can now be modulated by a new technic which may find application in television and FM communication. Picture or audio signals control the electron guns and cause the magnetron to generate an FM wave without amplitude modulation. Automatic frequency control can also be obtained by this method.



Under the influence of a static magnetic field and an rf electric field, an electron beam follows a spiral path within the cavity and frequency modulates the natural resonant frequency of a magnetron. Laboratory engineers of RCA reported that frequency deviations of 7 mc at 900 mc were obtained; that improved magnetron design with multi-gun elements may allow deviations of as much as 12 mc.

DIELECTRIC PROPERTIES AT 10 MC

C. V. Larrick
General Electric Co. Hanford, Wash.

The concepts of dielectric constant and loss factor are extended to frequencies of the order of 10,000 mc. To find their numerical values, resonant waveguide cavities are partly filled with the dielectric to be investigated and their properties measured. The dielectric is removed and the cavity dimensions changed to establish the same characteristics. Formulas to evaluate the dielectric constant and the loss factor from these data were presented. This method was used to test glass intended for tube sealings.

OSCILLATOR SYNCHRONIZATION

R. D. Huntoon and Albert Weiss
National Bureau of Standards
Washington, D. C.

The frequency of an oscillator can be controlled within narrow limits by injecting a small harmonic voltage of the desired frequency in some branch of the oscillator circuit. Recently Adler has shown that the synchronization is related to the frequency pulling characteristics of the oscillator. If the frequency and amplitude of oscillation are known as a function of incremental resistance and/or reactance in some branch of the circuit the response of the oscillator to a small harmonic voltage induced in this branch can be expressed in terms of a differential equation similar to that derived by Adler but with added generality. The solution of this equation gives the bandwidth of synchronization, the phase relation between oscillator voltage and injected voltage throughout the region of synchronization, and the amplitude changes observed in this region. Simultaneous equations describing the mutual synchronization of two or more oscillators can be derived which yield information of value for the linear acceleration problem.

When the oscillator is synchronized with the injected signal it becomes a linear voltmeter for measuring the amplitude of that signal. The device is linear from its noise level over a considerable range depending upon the amplitude of oscillation and type of oscillator. For an ordinary Class C triode oscillator with an amplitude of 200 volts the linear region covers about one volt. When used in this manner as a voltmeter the synchronized oscillator exhibits a voltage amplification of 4 to 10 from the ac voltage to be measured to the dc voltage which indicates the measurement. It is available at any frequency for which oscillators are now available including

the microwave region, since it is not necessary to restrict consideration to triodes or lumped circuits.

The device also can be made into a simple field intensity meter of medium accuracy for measurements at any frequency for which oscillators can be built. The range of direct utility without alternators, etc., is from about 10 microvolts per meter to about one volt per meter.

The response time is sufficiently rapid to allow the synchronized oscillator to operate as a linear demodulator for amplitude modulation signals having negligible frequency modulation and affording at the same time a demodulation gain of 5 to 10.

Consideration of the mutual synchronization of two oscillators of nearly equal power shows that the bandwidth of sychronization can vary from zero to twice the width for a single oscillator interacting with a fixed injected voltage. The injected voltage must arise from a source at least ten times as powerful as the oscillator under study if accurate measurements are to be obtained without exact knowledge of the coupling impedance.

The theory has been experimentally checked in detail for a simple triode oscillator operating at 11 megacycles.

BROAD BAND AMPLIFIERS

A. M. Levine and M. G. Hollabaugh
Federal Telecommunication Laboratories

The paper outlines calculations for input damping, instability due to feedback, etc. Calculated and measured values are given for various tube types and for frequencies throughout the 30-300 mc range. Graphed values of input resistance effective in actual amplifiers were found to follow the customary frequency squared approximately in the lower VHF region. For higher frequencies smaller resistances were observed. Graphs with frequency to the 2.5th power have been found to be sufficiently accurate for purposes of amplifier design with three common tube types—6AG5, 6AH6, 6AK5.

The tube damping values were taken for amplifier stages where short cathode leads were used but without other means of input admittance compensation.

Capacitive coupling due to the grid-to-plate capacitance in amplifier tubes is sufficient to give rise to instability in amplifiers in the VHF region. A limit to the minimum bandwidth obtainable with a given gain is determined as a function of the grid-plate capacitance of the amplifier tube. A 100 mc amplifier using four stages of 6AK5's will be unstable if the bandwidth is less than approximately 2 mc, assuming that the gain is not intentionally reduced or that some form of neutralization is used.

PULSED-FM MODULATION

Dr. Harold Goldberg
Bendix Radio Div., Baltimore, Md.

A new system of tele-communications was revealed which doubles the number of channels of a pulse-time modulated system by frequency modulating each pulse. The duration of each burst of radio energy is estimated to be approximately one-millionth of a second.

Until now microwave communication systems have achieved multi-channel operation by a "time-sharing" arrangement. By this means, several messages can be sent sequentially on the same radio carrier and the receiver separates this orderly sequence into individual messages. By frequency modulating each pulse, a second message may be sent on the same train of energy, thus doubling the potential of usable radio energy.

The main problem lies in receiver separation of the two channels—pulse-time and pulsed-FM. A special step-function recovery type of discriminator is used to separate the two channels. Circuits have been designed to suppress interaction, thus cross-talk can be kept down.

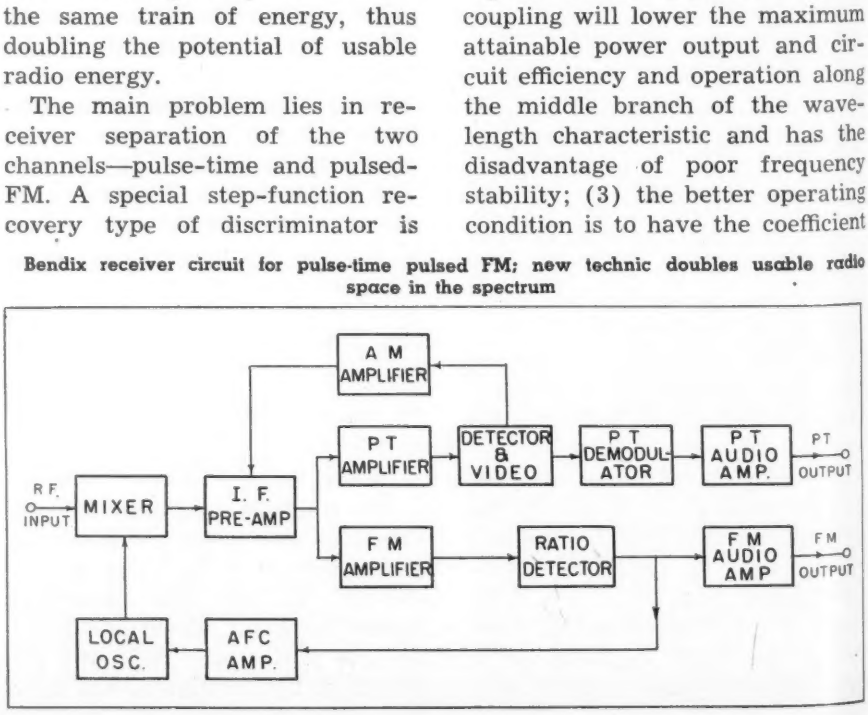
COUPLED-CIRCUIT OSCILLATORS

David K. Cheng
Cambridge Field Station, AAF

The starting point of this work is the tacit assumption that a properly designed oscillator adjusts its frequency of oscillation so that it maintains approximately a unity power factor at its tank circuit terminals, which is also the primary of the two-coupled circuit. One is then able to analyze the performance of the tube as an oscillator by the method of the contour diagrams on the one hand, and to treat the behavior of the coupled circuit as a pure circuit problem on the other. The unity-power-factor approximation provides a means of correlating these two and of analyzing the operating characteristics of the entire system.

Experimental investigation has been carried out on a 2 mc. coupled-circuit power oscillator. The experimentally obtained wavelength and loading characteristics check quite well with theoretical predictions. From the operating characteristics for various values of total secondary resistance under different degrees of coupling, conclusions may be drawn that (1) there is no advantage in operating a coupled-circuit oscillator at an over-limiting condition; (2) too loose a coupling will lower the maximum attainable power output and circuit efficiency and operation along the middle branch of the wavelength characteristic and has the disadvantage of poor frequency stability; (3) the better operating condition is to have the coefficient

Bendix receiver circuit for pulse-time pulsed FM; new technic doubles usable radio space in the spectrum



of coupling equal to or slightly less than its limiting value and the secondary circuit slightly detuned; the point of lowest frequency or a little after the point of highest frequency, where the power output and overall efficiency are maximum: (4) the magnitude of external load resistance put into the secondary circuit should be a compromising value between two conditions, namely: the limit of the existence of a region of oscillation stoppage on one side, and the avoidance of too large a portion of output power being dissipated in the circuit resistances on the other.

MICROWAVE GENERATOR

W. C. Brown
Raytheon Co., Waltham, Mass.

The behavior of a magnetron associated transmission line and terminating load is studied by means of an equivalent circuit over a large frequency range. For matched conditions, linear frequency dependence is assured. However, when the termination is not matched, tuning may result in frequency jumps. Three distinct resonant frequencies correspond to the same voltage. The standing wave ratio permissible to avert frequency jump is evaluated. Magnetrons do not determine the condition for preventing frequency jumps; pulling figure and length of line are important. Coaxial lines are better than waveguides in this respect. It is desirable to have as short a line as possible. Sudden jumps in output power also may occur.

COAXIAL-LINE SUPPORT

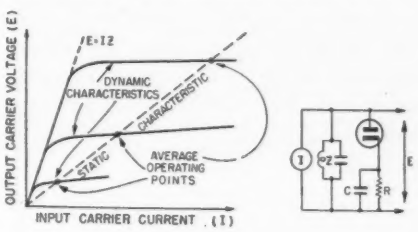
R. W. Cornes
Sperry Gyroscope Co., Inc., Garden City, N. Y.

Undercut beads were used to support the center conductor of a coaxial transmission line ⅞ inch in diameter and designed for 0 to 4000 mc. The equivalent circuit of this particular structure was a series of shunt capacitors across the line having a value of 0.05μμf; it operates as a low-pass filter. The image impedance is evaluated as a function of frequency. For best performance, the voltage standing wave ratio at 135 mc is made equal to unity, so that at this frequency the image impedance is equal to the characteristic impedance. At zero frequency the image impedance should be 99% of the characteristic line impedance. The reactance of line plus bead arrangement was measured by a cavity resonance method. The shorter the bead, the higher the maximum frequency passed; however, the bead must be sufficiently long to give adequate mechanical support.

FM DETECTOR SYSTEM

B. D. Loughlin
Hazeltine Electronics Corp.

A high conductance diode biased by a battery, placed in shunt with a high impedance resonant circuit, and fed by a constant current carrier source, is shown to produce an effective voltage limiter of the fixed threshold type. Such a system can be modified to have a variable level threshold by replacing the bias batteries with a long time-constant parallel resistor-condenser network. The resulting output from the dynamic limiter is a carrier whose amplitude is proportional to the average value of the carrier current, but which is relatively free from audio frequency amplitude modulation of the applied carrier.



LIMITER CHARACTERISTIC
FOR DYNAMIC LIMITER

550 MEGACYCLE AMPLIFIER

Raymond O. Petrich
Airborne Instruments Laboratory

A gain of over 10 db per stage has been obtained at 550 mc for a bandwidth of 20 mc using a 2C43 "lighthouse" triode in a grounded-grid amplifier circuit. The center frequency of the amplifier may be tuned from 550 to 600 mc and the bandwidth varied from 10 to 30 mc. Five stages have been connected in tandem giving an overall gain of 50 db. for a 20 mc bandwidth. A continuous-wave output of 5 watts may be obtained without external cooling. Each stage of the amplifier is of the grounded-grid type with an impedance-transforming band-pass filter in the output circuit to give the required bandwidth. The output filter is a double-tuned circuit consisting of two resonant coaxial-line cavities capacitively coupled together. A single tuned circuit is used at the input, since the response of the input filter is not as critical as that of the output filter, and the tube-loading effect lowers the Q of the cavity sufficiently to give a broad enough response. Both the input and output taps are adjusted to operate at a 50-ohm level.

DIRECT READING WAVEMETERS

G. E. Feiker and H. R. Meahl
General Electric Co., Schenectady, N. Y.

Quarter-wave, coaxial, direct-reading wavemeters were designed. Energy is coupled to and from the coaxial resonator by loops, and resonance is indicated by the peak reading of a dc instrument actuated by current from a crystal detector.

A precision wavemeter with a silver plated micrometer spindle as center conductor and with finger contacts of a special design was developed for the 8 to 12 cm range. It is direct reading in wavelength to within 0.1%, has a precision of reset of 0.02%, and requires approximately one milliwatt of power.

The necessity of putting this precision wavemeter into production for field use called for elimination of finger contacts and they were replaced by reentrant chokes.

The same design principles were incorporated in a similar precision wavemeter for the 12 to 17 cm range. Precision and accuracy are the same as for the 8 to 12 cm.

Extensive use of these precision wavemeters having reentrant chokes has shown that the calibration is maintained well within the 0.1% specification.

LANAC SYSTEM

Knox McIlwain
Hazeltine Electronics Corp., Little Neck, N. Y.

This system (described January 1947, TELE-TECH), exists today in an advanced state of design. Functioning equipments have been flight tested in three planes flying a total of more than 10,000 miles. Planes have been flown through dense fog within one mile of each other. Three commercial planes have

been landed in commercially unflyable weather with one minute spacing. No evidence of deterioration of performance with weather has been noticed, although some variation in range has been observed.

CAVITY RESONATORS

M. W. Wheeler
Westinghouse Electric Corp.

In the 3 cm region of the frequency spectrum a cavity resonator of quite practical physical dimensions may be used in cascade with a flow of electromagnetic energy to modify the frequency spectrum as a band-pass filter in four terminal network theory. Useful electric properties used to describe these cavities are resonant frequency, loaded Q (which is defined as 2 times the ratio of energy stored in the cavity to energy dissipated in the cavity and external circuit per cycle), and insertion loss (which has the same meaning as in four terminal network theory). It may be shown that electrically, these high Q resonators behave, within a limited frequency region, like a single parallel LCR combination, making it possible to define and determine the resonant wavelength from maxium response and loaded Q from the bandwidth.

To obtain the precision required in dealing with the resonance of a high Q device a high harmonic (2000th at X-band) of WWV's 5 mc standard is used as a reference frequency. The loaded Q of the device may be calculated from the bandwidth at some fraction of the total power, say at the Kth power point. The insertion loss of the device in transmission may be obtained from the same frequency response trace by the method of substitution.

PHASE FRONT PLOTTER

Harley Iams
RCA Laboratories

In the centimeter wave region it is not unusual to have an antenna, horn, or dish many wavelengths wide, across which the emerging radiation should be in the same phase, or vary in a particular fashion. Frequently the structure is simple enough that its performance can be inferred from the mechanical tolerances which were held during its construction, but for testing some of the more complicated rapid-scanning antennas and for doing research work it was found desirable to build a device for plotting on a sheet of paper the location of points in space at which the radiated field is in the same phase.

To accomplish this result, a comparison signal tapped off the waveguide leading to the antenna and the signal picked up by a probe mover in the field of the antenna are applied to a single crystal detector. When the two signals are in the same phase the output of the detector is a maximum; when they are opposing, the output is a minimum. To plot a phase front all that is necessary is to follow a line of maximum (or minimum) output, marking a sheet of paper to give a permanent record of the positions observed.

The accuracy with which the points on a simple phase front can be reproduced is about ±1/50 wavelength.

PROPAGATION IN HF TV BAND

W. B. Lodge
Columbia Broadcasting System, New York

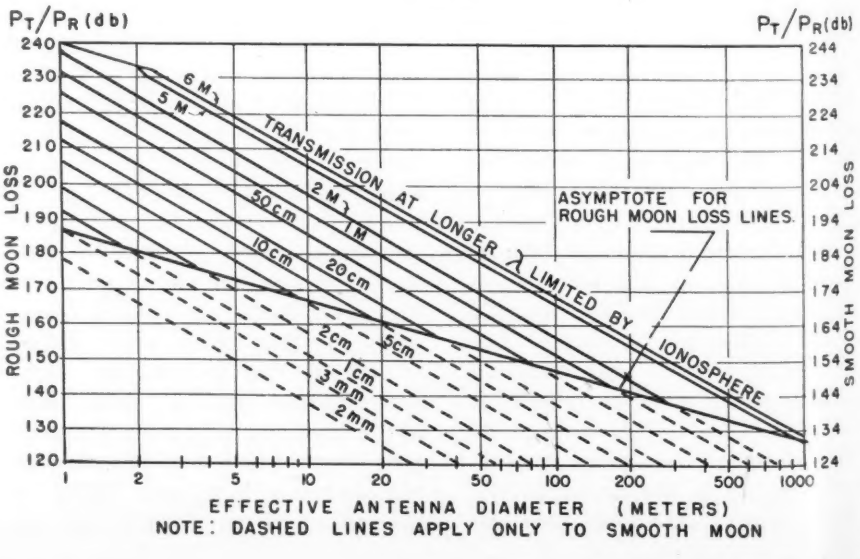
Two significant departures from standard practice in field intensity measurement are the use of a radar A scope to determine the time delay between direct, and reflected TV signals to study the problem of ghosts; the determination of the field intensity at a given point. Measuring equipment is taken to the point and the intensity is simply measured. The conventional method of approximating the field intensity by reference to a generalized coverage pattern will yield inaccurate data. Television signals depend to such a large extent on the nature of built-up areas that a few feet may mean the difference between a consistent strong signal and an erratic weak one.

Measurements were made of transmissions from the W2XCS Chrysler Tower antenna which had an effective radiated power of 10 kw. The test frequencies were 490 and 700 mc. Except for stronger shadows at higher frequencies, the propagation characteristics of both were essentially uniform.

Adjacent channel operation at 700 mc was shown to be feasible for two stations operating within 100 miles of each other; co-channel operation within 150 miles. Noise and man-made static at these frequencies is practically non-existent. Passing automobiles as little as 25 ft. away produced no ignition interference.

Results show that if a TV receiver cannot pick up the direct signal, orientation of the antenna on a nearby reflecting object such as a water tower, smokestack, or tall building, may allow satisfactory reception. One of the chief causes of television ghosts was reported to be the passing of overhead aircraft. Planes in flight do not necessarily have to be between the receiver and the transmitter, but can be at any azimuthal angle and still cause multi- path reception.

FTR experimental transmissions to moon indicate attenuation losses for various wavelengths of propagation. Results are based on assuming both smooth and rough moon surfaces



Strongest contention of this talk was that approximately 91% of the population in the Metropolitan area out to the first 25 miles can be served with a consistent strong signal practically 100% of the time. For those television sets in high built-up areas or behind hills, the only solution is to put up a high antenna or use a reflected signal.

RADAR FIRE CONTROL

Robert M. Page and John B. Trevor, Jr.
Naval Research Lab., Washington, D. C.

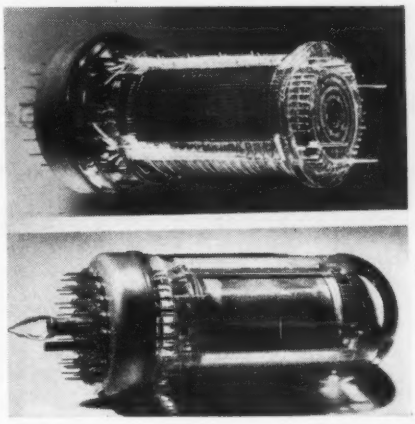
A discussion of the broad requirements which must be met by a radar system for aiming naval guns. A complete naval radar system, for first locating enemy airplanes, and then aiming guns with the required accuracy, consists of at least two radars and many other components. Very high standards of accuracy must be provided since the penalty for failure may be the destruction of a naval vessel.

ELECTROSTATIC STORAGE

Jan Rajachman
RCA Laboratories, Princeton, N. J.

An ingenious computing device obtained by pulsing the elements of a special radio tube circuit connected as a valve-type on-off device. For such work an inner memory organ capable of fast registry and delivery is necessary for long sequences of mathematical operations so that the results of one operation can become the data for a subsequent one without the intervention of any terminal mechanically or humanly limited equipment.

The selectron is a vacuum tube for the inner memory of an electronic computer in which these partial answers are stored in terms of electrostatic charges on a definite location on the surface of an insulator. A sheet of electrons bombarding a large area is inter-

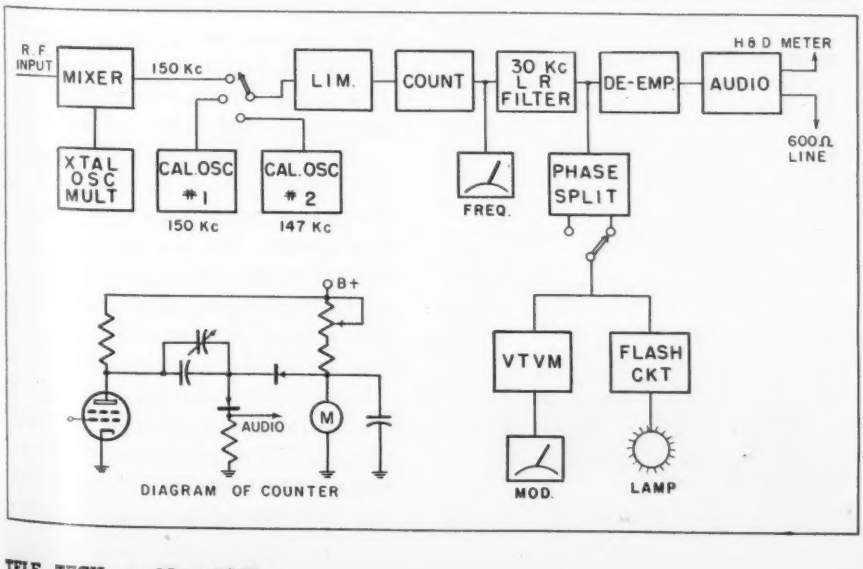


cepted by two sets of spaced parallel metallic bars at right angles to each other, creating a checkerboard of windows. Electrons pass through a window only if all boundary bars are at some definite positive potential and are stopped when one or more bars are at some negative potential.

The bars are internally connected in such combinations that by applying on-off voltages to a relatively small number of sealed-in leads the flow of electrons stops through all windows except a positively selected one. To register a signal, momentarily, a specified window is opened to the exclusion of all others, and a voltage pulse is applied to a metallic plate backing the insulating surface. The storing time is indefinite. The reading requires no scanning over unwanted elements, follows the reading call by a few millionths of a second and can be repeated indefinitely.

In experimental tubes the source of electrons is an axial cathode and the checkerboard of windows has the form of a cylinder. The tube has a capacity of 4096 = 64 x 64 on-off signals.

Federal Telephone Radio circuit for FM station monitor. Circuit uses counter-type FM detector (schematic shown) for noise, distortion, frequency and modulation measurements



DISTORTION-NOISE METER

C. W. Clapp
General Electric Co.

A bridged-T type rejection filter covering the range from 50 to 15,000 cycles was constructed to be incorporated in a noise meter. It rejects the fundamental while permitting the harmonics to pass. In the basic circuit, two terminals are connected by two capacitors in parallel with a resistance and an inductance either in series or in parallel extending from the point between the two capacitors to the other two terminals. A combination of the series and the shunt inductance resistance circuits gave best results. In the final circuit the inductance is replaced by a reactance tube supplied with suitable voltages by a cathode follower Among other uses, the circuit can be adapted to operate as a noise meter.

THREE-DIMENSIONAL DATA

O. H. Schmitt,
Airborne Instruments Laboratory, Inc.,
Mineola, N.Y.

A perspective representation of data on cathode ray screen is suggested. This type of representation is commonly used by draftsman and gives the viewer of a two-dimensional picture the impression of looking at a three-dimensional object. Several projection methods are available, most of which involve quantities obtainable by means of electrical circuits from the information supplied, for example, by a radar system. By changing the adjustments it may be possible to "view" one or several objects from different sides within a certain angle. To improve the illusion of a three-dimensional object, stereoscopic viewing, or a special image for each eye may be supplied.

The Theory and Design of Speech Clipping Circuits

By M. H. DEAN, Engineering Division, RCA Victor Co., Ltd., Montreal

Engineering an amplifier for communications services that will increase effective power of an AM carrier by at least five, without over-modulation

• Ever since the start of voice communication a severe limitation has been imposed by the restriction to 100% modulation on signal peaks. Due to the irregular distribution of energy in sounds, and speech in particular, the modulation utilization factor is very poor if overmodulation is to be avoided. Indeed as the spectrum has become more crowded and the allowable frequency of overmodulation peaks has been decreased the average modulation depth has actually been decreased.

A brief resume of the development of present requirements for communication type amplitude modulated transmitters is given in order that the reader may fully realize the conditions which must be met by the modulation system even if no increase in effective level is required.

Initially little attention was paid to overmodulation in communication type transmissions as long as it was not so severe as to affect the intelligibility.

As more transmitters were put on the air, and several were operated in a small area such as an aeronautical ground station, the interference problem became severe. This was investigated by Sandretto[1] who found that for 20 kc. separation between a transmitter and a receiver there must be no transmitter sidebands of a strength comparable with the desired signal within the pass band of the receiver. A low pass filter, after the modulator, effectively eliminated harmonic (or high fundamental) frequencies which appeared in the speech system. Any overmodulation of the carrier, however, would immediately cause higher order sidebands to appear again.

THE crowding of the communication frequencies devoted to AM has reached a point at which any overmodulation produces splatter and interference to some other station. In an effort to improve this condition it has been the practice to use a peak limiting or compressor, amplifier. It will be shown that the advantage gained by such an amplifier is not as great as may be expected and an amplifier will be described which will overcome the limitations of the conventional compressor. With this new amplifier an increase in effective level of 10 db or better is achieved and all danger of sideband splatter is eliminated.

To control modulation level Sandretto installed a compressor which had a flat output characteristic for the last 20 db. increase in input. Due to the finite time required for compression to take place, a peak clipper was also required to prevent the initial pulse in the compressed wave from overmodulating the transmitter. The distortion introduced by this system, although low, was further taken care of by the output filter and adjacent channel interference was found to be negligible. It should be noted that no attempt was made here to improve the average percentage of modulation but only to eliminate interference. Any gain in modulation depth was secondary.

Another place where overmodulation must be very carefully controlled is the case when two or more channels are applied to a single carrier (e.g. voice and sub carrier or voice and tone such as for simultaneous aeronautical radio range transmission). In this case it is very important that the voice modulation does not exceed its allotted percentage, as otherwise severe cross modulation will be present. A peak clipper would definitely be required to obtain freedom from such effects.

Another approach to increasing the modulation level has been made by eliminating or suppressing the low frequencies in speech on the theory that the major part of the power is located below about 500 cps. It has also been shown that very little intelligence is contributed by this portion of the spectrum. This improved the intelligibility of the transmission as a considerable increase in input level was possible without undue over-

Fig. 1—The "PLEX" Amplifier

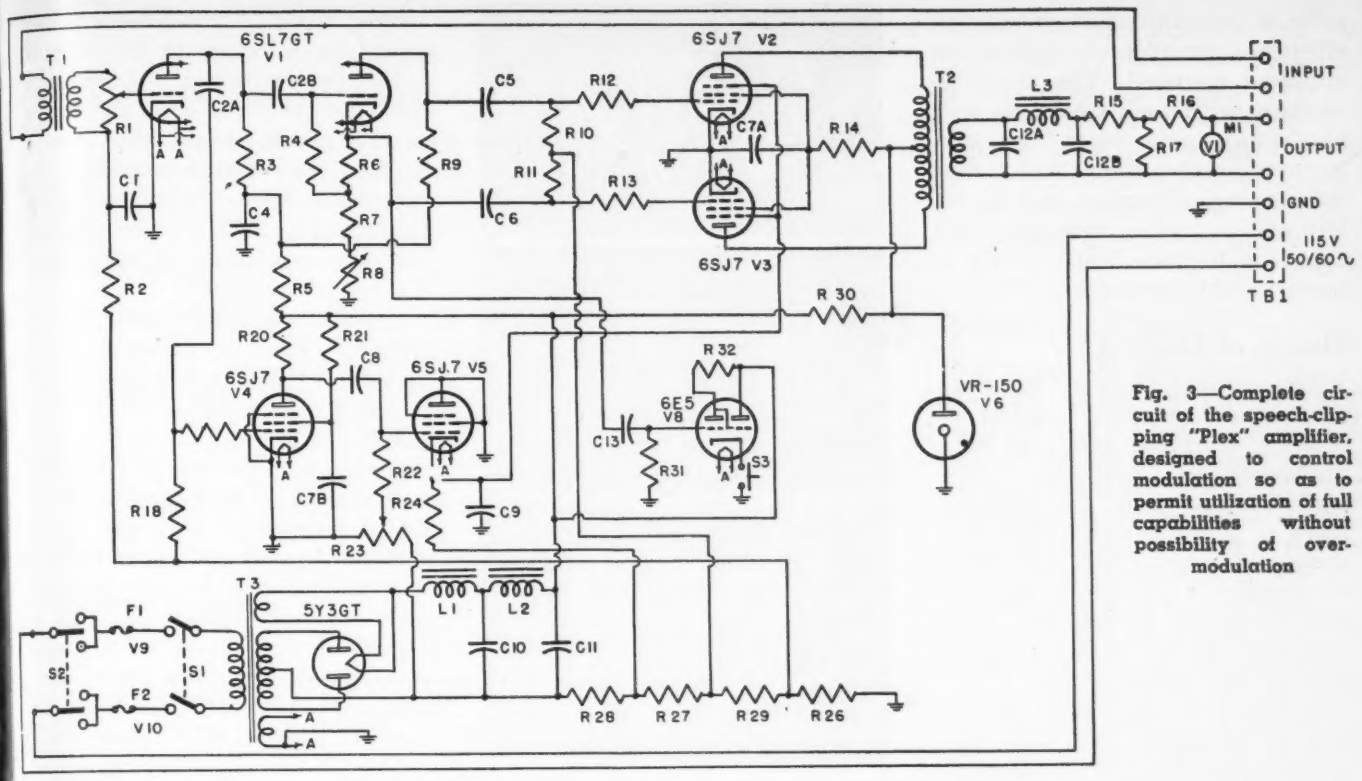


Fig. 3—Complete circuit of the speech-clipping "Plex" amplifier, designed to control modulation so as to permit utilization of full capabilities without possibility of overmodulation

modulation as checked with an oscilloscope.

Actually while the apparent modulation level can be increased by this method the problem of interference is still present. Sivian[2] shows that when a high speech level is used such as would normally cause most severe overmodulation, peaks rising to within 4 or 5 db of the maximum low frequency peaks occur up as far as 4000 cps. It is obvious then that if both improved level and freedom from overmodulation interference are to be obtained, a different system must be used.

Compressor Operation

The compressor or peak limiter previously mentioned would appear to be the solution until its operation is examined. A conventional compressor incorporates a circuit which acts rapidly on a peak signal to reduce the amplification to maintain a constant peak output level for an increase in input above a given point. A range of 20 db. or more thus may be accommodated. Once the gain has been reduced it must return to normal at a relatively slow rate otherwise severe distortion will be introduced on the wave immediately following the compressed peak.

In standard broadcast compressors 90% recovery does not occur for 2 to 7 seconds. This interval could be made less for speech but should not be so rapid that it is equal to the syllabic rate. As the majority of syllables in speech contain at least one peak it may be seen that the gain will be reduced for a major portion of the time. For example if the input level is set so that peaks just reach the limiting point and it is then increased 20 db for normal speech the actual increase in output would only be a fraction of 20 db due to the fact that each peak would reduce the gain by 15 to 20 db.

Under these conditions reducing the low frequency response before compressing would help as the limited peaks then would occur at less frequent intervals. As each operation on the speech serves to reduce the intelligibility somewhat such a process cannot be carried too far. Also, as already pointed out the finite operating time required by the limiter will allow initial peaks to pass unattenuated and for maximum freedom from adjacent channel interference a further control element is required.

A full appreciation of this shortcoming in the use of a compressor for obtaining maximum increase in modulation depth is revealed by a study of the way intelligibility is carried by a speech wave. It has been found that the major power-carrying components of speech are the vowels (or semi-vowels such as l, m and n). These give character or quality to speech and provide a general outline of the intelligence. The minor inflections which separate and render distinguishable different words with the same basic vowel sounds are produced by the consonants which are much lower in power. When single syllable words are transmitted through a compressor those consonants immediately following the vowel sound will be reduced in amplitude and in cases where these are the distinguishing sounds in a word the increased level of the remaining parts of the word are of no advantage. In a poly-syllabled word this is even truer.

If now the peak sound is limited within itself the sounds immediately following will be unaffected by the peak and the amplitude of all low level sounds will be increased. The limited peak will be severely distorted but no transients will carry over to interfere with following sounds.

The fact that the vowel sounds are so basic and characteristic makes them easily recognizable in

spite of the consonant sounds; the effect is a considerable increase in apparent volume.[8] The apparent increase with such treatment will not be quite as great as the actual increase in the unmodified signal due to the distortion introduced but will be much more than the apparent increase when using a conventional compressor.

Theory of Clipping

The process known as peak clipping or chopping consists of squarely chopping peaks off at a predetermined amplitude. On a high intensity peak the resulting wave is almost square (Fig. 2C) and hence contains many odd order harmonics. If not removed these would create excessively wide sidebands and cause severe adjacent channel interference.

A low pass filter, such as was used by Sandretto,[1] will take care of this condition. The correct cutoff point must be a compromise between bandwidth and intelligence. W. B. Snow[3] has established that the average listener can detect the difference in the average male voice if the bandwidth of the reproducer is less than 100 to 7000 cps. For loud talking, however, the main power lies between 200 and 4000 cps and this bandwidth is adequate for good quality communication circuits.

When peaks have been clipped care must be taken to insure a minimum of phase distortion in the remainder of the audio circuits. This normally requires exceptionally good frequency response, extending well beyond the pass band of the system. Actually if the low pass filter is designed to have a rather gradual change in phase, such as a single constant K section, the harmonics are attenuated sufficiently before they are shifted far enough in phase to increase appreciably the peak amplitude of the wave.

The following circuits then require a response that falls off more slowly than the filter, at least up to about 8000 cps. At the low frequency end the situation is not so good, as here the fundamental is shifted in phase and being so much larger than the higher order harmonics the effect is much greater. The result is a distorted wave having a peak amplitude as much as twice as great as the original squared wave. This means that if the squared wave was just causing 100% modulation then overmodulation would be present.

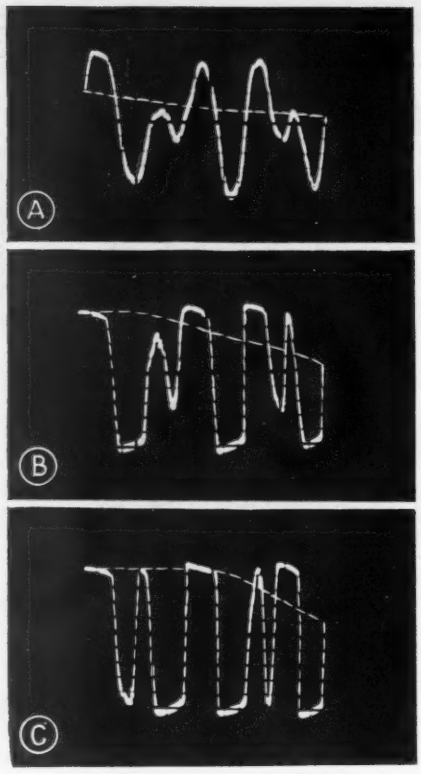


Figure 2
Peak Clipping of a Composite Wave
(a) The unclipped wave—note the complex form of the low level peaks
(b) 10 db of peak clipping—high level peaks are squared off but complex low level peaks are undistorted
(c) 20 db of peak clipping—low level peaks have now reached the maximum amplitude without distortion. The wave here is displaced by one half cycle so that the right hand low level peaks correspond to the left hand ones above and vice versa

Practical Clipper Design

In practice if the low frequency response following the clipper stage is 3 db or less down at 100 cps this overmodulation is not serious. The harmonics produced which are of any appreciable amplitude all fall below 4000 cps. That is, they are within the normal pass band of the system and would not be eliminated by the low pass filter in any case.

Peak clipping can be done in a number of ways all of which may be divided into those involving the cutoff characteristic of a tube, or current flow when a fixed bias has been exceeded. The former method causes less trouble due to time constants as no current flows in the controlling circuits and a very simple circuit is possible.[4,9] The principle objection to this circuit is that even with sharp cutoff, high mu tubes there is some curvature of the characteristic near cutoff. This will result in distortion before cutoff is reached, a condition which should be avoided as this distorts the low amplitude "intelligence" portion of the signal.

Circuits utilizing current flow may use diodes or triodes.[5,6] Lower distortion below the clipping point is possible with this method but a number of precautions must be observed. The principle of operation is that a biased tube element offers a high impedance until the signal reaches the bias point, above which the impedance is low. By feeding such a biased element through a high series impedance no increase in output voltage will occur once the conduction point is reached. As current flows in this circuit great care must be taken to avoid time constants which might change the operating conditions not only in the signal circuit but in the bias supply. A second consideration to such a circuit is that the conducting element must have a low shunt capacity if good high frequency response is to be obtained.

Diodes as the shunting element satisfy the second condition but must be supplied with fixed bias which offers the difficulty of obtaining low impedance unless batteries are used. This is usually undesirable. Grids of push pull tubes offer a more suitable circuit as shown in Fig. 3 at V2 and V3. The bias is supplied from the power supply bleeder giving a low impedance source and no capacitors are required. The input capacity is of more consequence now, however, as shown by the equation:

$$C_i = C_g + C_{gs} + (1 + A)\, C_{gp}$$

where

C_i = input capacitance
C_g = grid-cathode capacitance
C_{gs} = grid-screen capacitance
C_{gp} = grid-plate capacitance
A = amplification from grid to plate

C_i will be a minimum if A and C_{gp} are both small such as a pentode with low plate load resistance.

For a given value of C_i the maximum series grid resistance will be limited by the desired high frequency response. If 4000 cps is the

TABLE I

PLEX AMPLIFIER PERFORMANCE SPECIFICATIONS

Input Impedance:	600 ohms balanced or unbalanced.
Output Impedance:	600 ohms unbalanced.
Normal Output Level:	Approx. 6mw. (at clipping point)
Normal Input Level:	–3 dbm max., –42 dbm min. (at clipping point)
Maximum Input Level:	25 db above normal input for maximum clipping.
Maximum Output Level:	Less than 15% in amplitude above normal output for up to 20 db of clipping.
Frequency Response:	Within 1 db for any two frequencies between 200 and 4000 c.p.s. more than 25 db down at 10,000 c.p.s.
Distortion:	Less than 5% at 400 c.p.s below clipping point, hardly noticeable on male voice over standard communication system at 20 db of clipping.
Noise Level:	–42 dbm maximum at full gain and expansion inoperative.
Maximum Expansion:	Output –47 dbm maximum for input 30 db below normal 0 dbm for input 10 db below normal.
Expansion Characteristic: (with 20 db of clipping)	Gain increase in less than .005 second. Gain increase 90% in .05 second.
Power Input:	115 volts, 50/60 cycles per second, 32 watts.
Fusing	Both sides of line, .5 ampere "Slo-Blo" type.
Indicating Instruments:	Clipping indicator — 6E5 tube, eye closes on peaks of approximately clipping level. Output Meter — Medium speed db meter.
Attenuator:	45 db range, 1.5 db for step, last step infinite.

upper frequency the series resistor for a pentode under the stated conditions will be sufficiently high for satisfactory clipping (of the order of one megohm).

The Plex Amplifier

If, now, it is desired to drive this clipping circuit with a resistance coupled amplifier a further precaution is necessary. This is to ensure that the time constant of the coupling circuit does not cause compression as well as clipping. Compression can be minimized by making the driving source fairly low impedance, making the grid return resistor small compared with the grid series resistor and making the grid coupling capacitor as small as possible. With a lower frequency range of 200 cps the RC product can be made small enough for good operation.

The complete circuit of such an amplifier is shown in Fig. 3 and the performance specifications in Table 1. V1 is a voltage amplifier and phase inverter and V2 and V3 are the clipping tubes. V7 is an electron "tuning eye" to indicate peak signal level. It is arranged to just close when the signal reaches the clipping point. V4 and V5 are respectively an expander amplifier and rectifier, operating on the suppressors of V2 and V3 to give a squelch action in the absence of signal. The plate and screen voltage of V2 and V3 are taken from a voltage regulator to maintain good regulation as the gain is varied.

The squelch feature is a necessity when using clipping if there is any background noise at the transmitting point. Due to the greatly increased level possible this background would prove objectionable in the absence of speech. When the squelch is introduced any noise which is somewhat below normal voice level will not open up the amplifier gain.[7]

Fig. 1 gives a view of the amplifier itself. It is mounted behind a standard 19 in. panel 5¼ in. high. The clipping indicator, power switch, volume indicator and calibrated input attenuator are located on the front panel. The squelch level control is located inside and is accessible through the hinged center section of the panel. This unit is known as the PLEX (peak limiting expanding) amplifier.

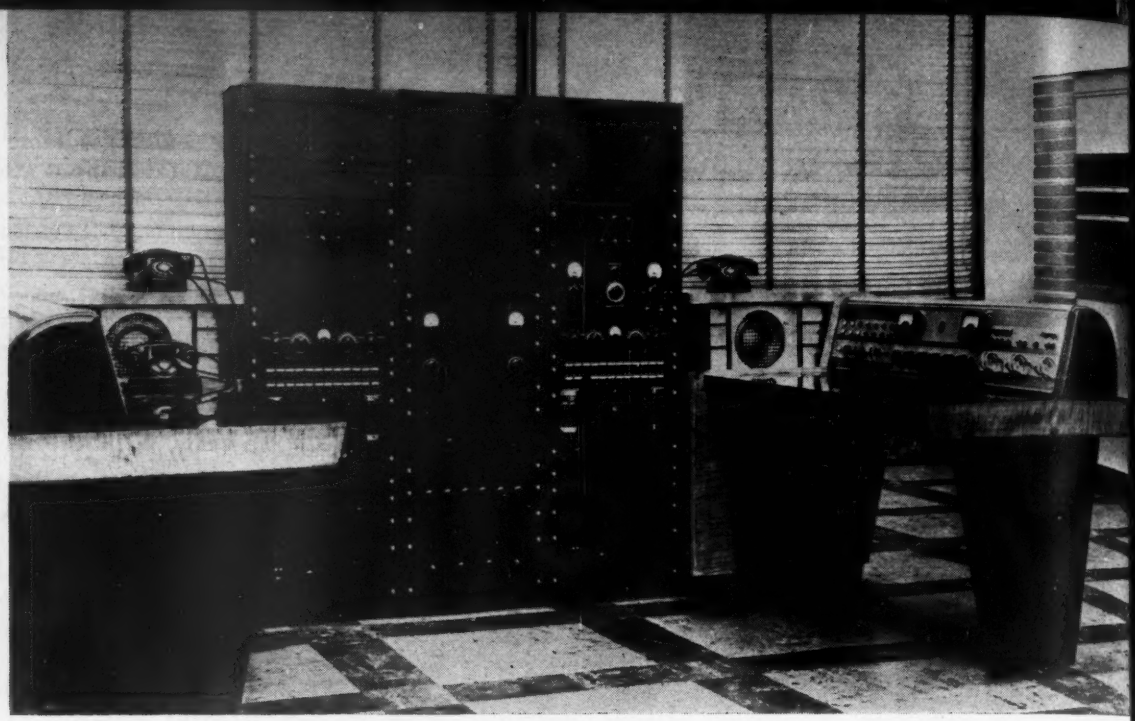
Tests With the PLEX

In operation the gain control is varied with normal input (voice) signal until the indicator shows that the peaks are just clipping—i.e. the eye just closes. The control is then advanced the number of db by which it is desired to clip. The peak output level is fixed by the circuit constants and in this particular case is adjusted by a fixed output attenuator to six milliwatts. The circuit is capable of any output up to 100 milliwatts. When used as a driver for a modulator the modulation gain control is adjusted so that the clipped wave gives just under 100% modulation. This adjustment should be made with an oscilloscope and once set does not require changing as objectionable overmodulation will be impossible regardless of the input speech level to the PLEX amplifier.

Fig. 2 shows oscillograms of the PLEX output with a composite wave such as occurs in speech. The first oscillogram (2a) shows the wave when the peak amplitude is just under the clipping point. Fig. 2b shows the same wave when clipped 10 db. The higher amplitude peaks are squared off while the lower amplitude portion of the signal is greater but undistorted. The third oscillogram 2c shows 20 db of clipping. The maximum amplitude still has not increased but now almost all the peaks are clipped. It is important to note that the unclipped peaks are still undistorted, as these represent the "intelligence" portion of the signal as previously explained.

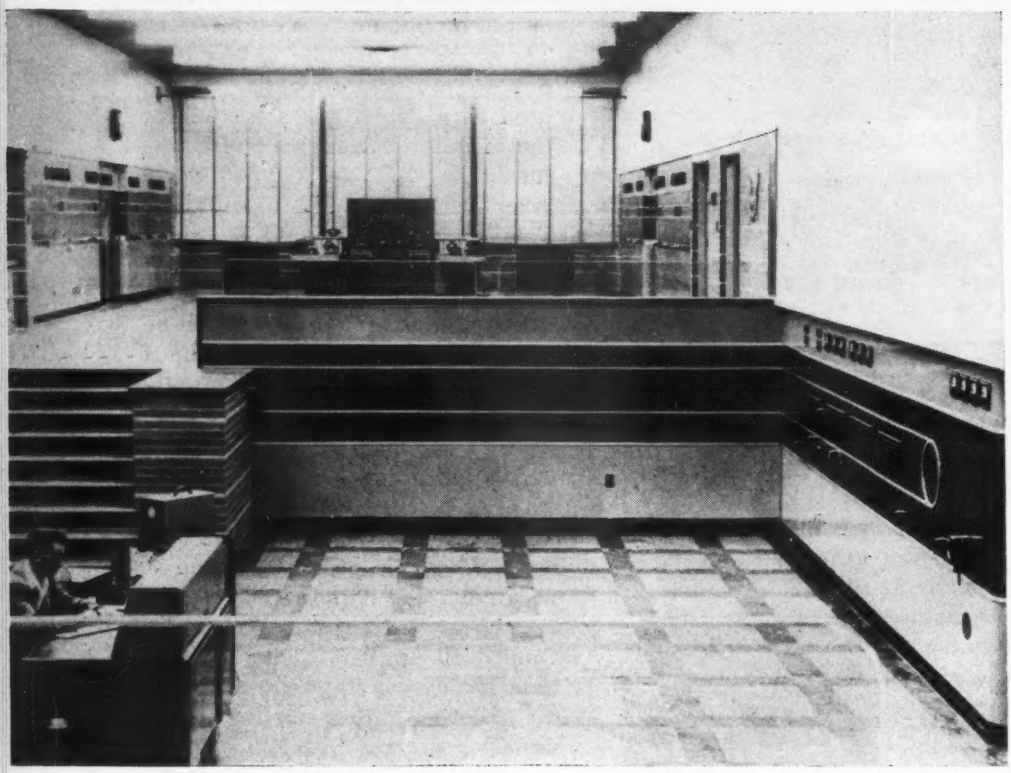
A number of tests were made with the PLEX amplifier to determine its usefulness. First the amount of clipping was increased in 5 db steps until the distortion began noticeably to affect the intelligence. Up to 20 db clipping,

(*Continued on page* 116)

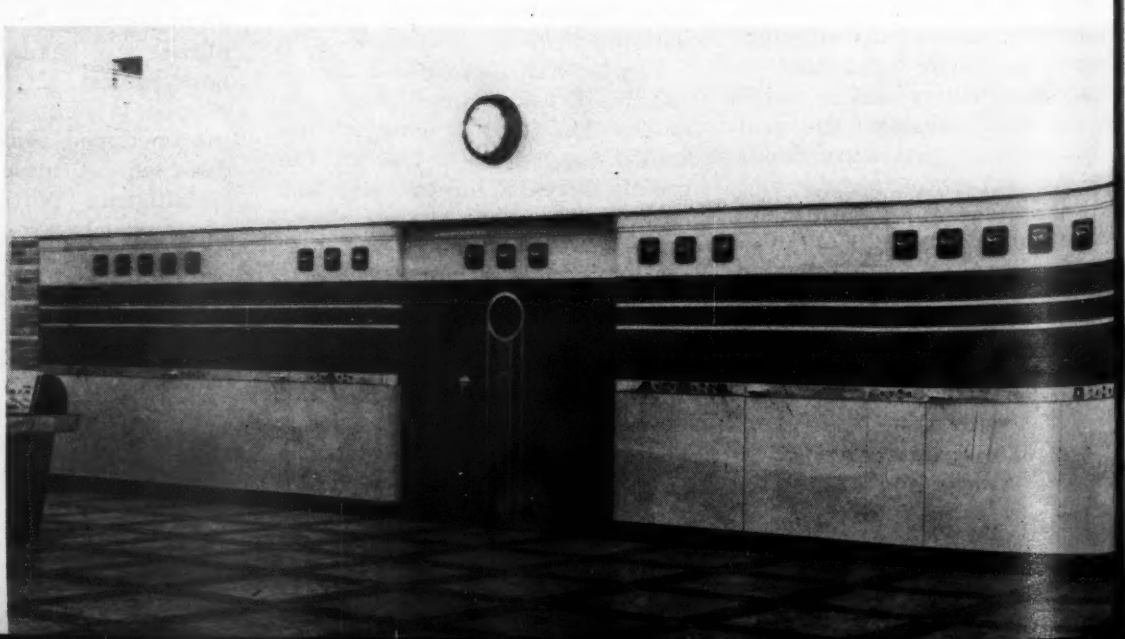


General view of the pair of control panels used with the two 50kw short-wave RCA transmitters in CHTA of the Canadian Broadcasting System, Sackville, New Brunswick

Canada's Highest Power



Control equipment pictured above is at the rear center here, with the two SW transmitters at the sides of the mezzanine. Standard 50-D transmitter is on lower floor at right



Front view of one of the two 50kw short-wave transmitters. Monitoring, test and control equipment is behind the console and appears in the top photograph

Automatic Arc-back Indicator

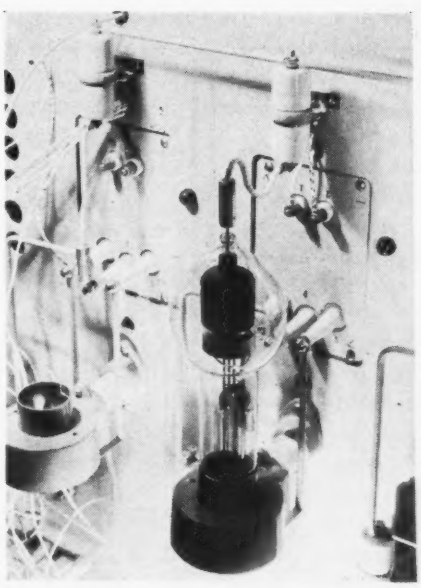
Unusual circuit incorporated in new Western Electric 10kw FM transmitter indicates troublesome rectifier, reduces time lost off the air

• The heart of the arc-back indicator circuit provided in the new Western Electric 10-kilowatt FM transmitter is a small toroidal wound transformer which provides in a simple manner the necessary insulation between the high voltage tube circuit and the low voltage indicating circuit and which responds only to reverse current in the rectifier tube.

This transformer has a single turn primary consisting of the anode lead of the rectifier tube carried through the center of the toroid in a ceramic bushing. The secondary consists of a multi-turn toroidal winding on a permalloy tape core, at essentially ground potential.

The core is operated in a saturated condition by passing a biasing current of a few milliamperes dc through the multi-turn secondary. This bias current is so poled that the normal primary current pulses (the forward current through the rectifier tube) are in a direction to add to the magnetizing force of the bias current.

As the bias current saturates the core, the addition of the primary pulses will have relatively little effect on the core flux and will therefore induce little voltage in the secondary winding. However, if the current in the primary is reversed (such as would be caused by an arc-back in the rectifier tube) its effect bucks the magnetization of the bias current and the resulting large flux change will induce a substantial voltage in the secondary winding.

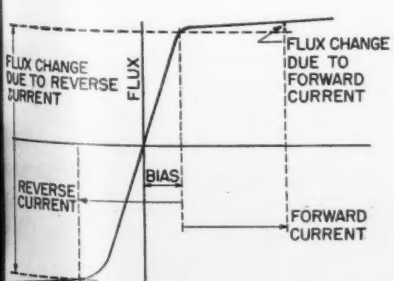


The saturated toroidal transformer, heart of the arc-back indicator circuit, is mounted above its associated mercury vapor rectifier tube

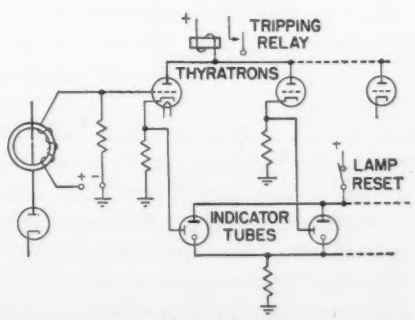
By using permalloy tape for the core of the transformer a magnetization curve is obtained which is very steep for low magnetizing forces and has a very sharp knee. The steeper the curve up to the knee and the sharper the knee, the greater will be the ratio of output voltages for the same values of reverse and forward current. In the design of this transformer this ratio is between 20 and 30. This difference in output voltage may be used to control a vacuum tube which is biased to be inoperative on the small output voltage from the forward current pulses but is operated by the much higher voltages produced by the reverse current.

For the actual indication, a cold cathode three-element gas filled tube is used. When sufficient voltage is applied to the control electrode of this tube the resulting ionization permits the gap be-

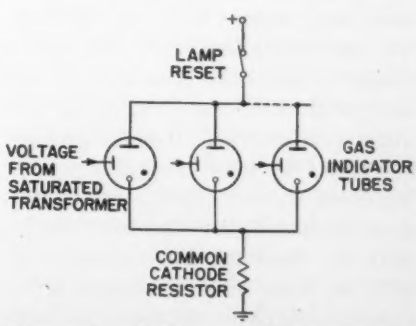
(*Continued on page* 125)



Graph showing the high ratio of sensitivity, reverse compared with forward current, of the toroidal transformer



Schematic showing the manner in which the circuit is arranged so that only the indicator for the first tube to arc-back is lighted



Manner in which small thyratrons and tripping relays are used in the arc-back indicator circuit to give fast protection

Survey of World-Wide Reading

Electronic news in the world's press. Review of engineering, scientific and industrial journals, here and abroad

A Velocity-Modulated, Multi-reflection Tube*

The multi-reflection tube is based on the principle of velocity-modulation, i.e., an electron beam is first velocity-modulated, then density-modulated, and oscillations are induced when the density-modulated beam traverses a circular modulator aperture conductively connected to a resonant system. Similar to the construction of a reflex Klystron, buncher and catcher apertures are identical and only one resonant system is provided in the multi-reflection tube. However, its operation differs considerably from that of a reflex Klystron in that the modulated beam oscillates backward and forward in the cathode-reflector electrode space and repeatedly traverses the modulator apertures.

To set up a density-modulated electron beam, the electric potential distribution in the modulator-reflector electrode space, (Fig. 1) is so shaped that all electrons retarded by the modulator have identical transit times regardless of the amount of retardation. In other words the time intervals the retarded electrons are spending in the modulator-reflector space, before their return to the modulator, are identical; this time interval is equal to an odd multiple of one half period of the oscillating frequency. Similarly all electrons accelerated by the modulator have identical transit times, this transit time exceeding by one half period that for the retarded electrons. It will be seen that a square-wave electron-density distribution results, the returning electron beam current at the modulator aperture being zero for one half period and equal to twice its original value for the following half period.

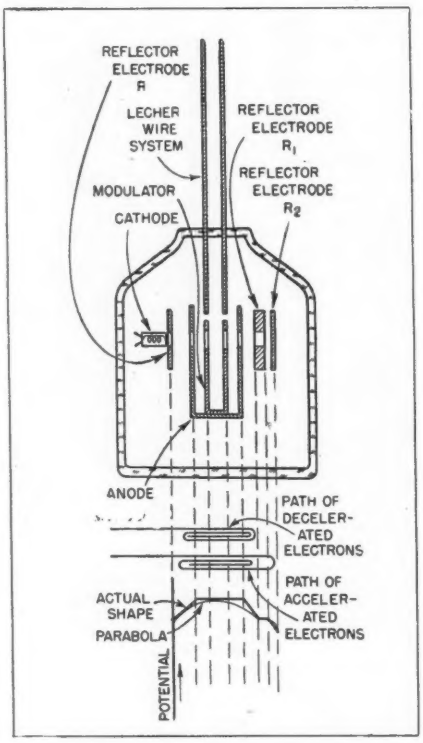


Fig. 1 Schematic of multi-reflection tube also illustrating electron paths and potential distribution in tube

The square-wave density-modulated beam traverses the modulator at a retarding phase of the modulator voltage and gives up energy. All electrons in the cathode-modulator space are returned to the modulator after identical time intervals equal to an odd multiple of one half of the oscillation period. This assures that the electron density distribution remains undisturbed and that a square-wave beam current of correct phase passes the modulator apertures once more but now in the direction toward the reflector electrode. Reflection at the far end of the tube again reverses the direction of electron travel and so on. Electrons are slowed down as energy is extracted from them at each passage through the modulator apertures except for the first passage.

It is essential that the period of the electron-beam density-modulation remain constant, though the electrons lose energy and their velocity is consequently reduced. To assure constant electron-beam density modulation, the transit times for all electrons must be independent of their velocity over the path from modulator apertures to reflector electrode space back to the modulator apertures and over the path from modulator apertures into the cathode-space and back to the modulator aperatures. This requirement is met if the retarding electric field strength is proportional to the distance from the modulator. Then the electrostatic potential varies as the square of that distance, i.e., it has a parabolic shape, (Fig. 1). Under these conditions the fast electrons will travel a longer path than the slow electrons, compensating for their higher velocities so that electron transit time is independent of initial electron velocity. The potential field is so dimensioned that the transit time is equal to an odd multiple of half the oscillation period.

A sufficient approximation of the desired parabolic potential distribution is realized in the actual

*F. Coeterier (Philips Technical Review, Eindhoven, Holland, Vol. 8, No. 9, pp. 257-266)

tube by the combination of a central equipotential field between the two anode apertures, (Fig. 1) and two linearly decreasing fields between the anode apertures and reflector electrode R_1 to the right and electrode R near the cathode, respectively.

To introduce the additional delay for the accelerated electrons required for the modulating process, reflector electrode R_1 has a considerable thickness and a further reflector electrode R_2 is provided. Decelerated electrons will reverse before reaching electrode R_1, while accelerated electrons, which take longer paths, will traverse electrode R_1. The latter will be detained in the space between electrodes R_1 and R_2 for exactly one half period of the oscillation. This causes them to return simultaneously with the retarded electrons of the preceding half period so that the current density is doubled for alternate half periods while it is zero for the remaining half periods. From this instant on, the square-wave intensity-modulation is preserved, no electron ever acquiring enough velocity to reach the space between electrodes R_1 and R_2. The density-modulated beam oscillates backwards and forwards across the modulator in correct phase to give up energy at each crossing.

A tuned Lecher-wire system consisting of two metal strips serves as output circuit and permits extraction of the fundamental component of the square wave; all harmonics are discarded. The metal strips are capacitively coupled to two other metal strips which are provided with the circular modulator apertures. The electron beam is centered by an axial magnetic field. Careful choice of the value of the centering magnetic field intensity may considerably increase tube efficiency.

For the type of multi-reflection tube illustrated in Fig. 2, the effective power output is 15 to 20 watts at a wavelength of 12 cm. Efficiencies of 50% may be obtained, compared with 20% for conventional reflex Klystrons. Multi-reflection tubes are particularly recommended for dielectric heating at ultra high frequencies. Continuous or pulsed operation is possible.—JZ.

Fig. 2 Photograph of multi-reflection tube showing three reflector electrodes and Lecher wire system. Modulator is hidden inside anode prism

KD_2PO_4 as Piezoelectric Substance

Van Vijve (Radio Revue, Anvers, Belgium, January, 1947, pp. 322 and 327)

The piezoelectric properties of KH_2PO_4, potassium dihydrogen phosphate, are reported in an article by W. P. Mason published in the July, 1946, issue of the Bell Laboratories Record. It appears that KD_2PO_4, the corresponding heavy hydrogen compound, where the light hydrogen atoms are replaced by the heavy hydrogen atoms, has piezoelectric properties and is of practical interest. Both crystals can be grown, artificially though by different methods. At conventional operating temperatures, the temperature coefficient of KD_2PO_4 is zero, which is not true for KH_2PO_4. Also the value of the piezoelectric constant is doubled by the substitution of heavy hydrogen for its light isotope.—JZ.

Mass Production Tester for Radio Equipment

R. G. G. Williams, J. E. Marshall, H. G. T. Bassmire, and J. N. Crawley (The Journal of the Institution of E'ectrical Engineers, London, England, Part III, pp. 20-26)

The test equipment described is the most recent of series developed over the past 5 years by Murphy Radio Ltd. for rapid, automatic sequence testing of electronic circuits in radio receivers. The instrument is adapted for ac and dc circuit checking. It is based on comparison against a standard set. The standard and test element are fed in series from a 1000 cycle supply and connected to the grids of a differential amplifier.

Provisions are made for checking up to about 90 different circuit paths by making use of two telephone selector switches in cascade; these switches are automatically operated at approximately 5 steps per second. If a permitted tolerance of 30% is exceeded, a trip mechanism stops the stepping switch and interrupts operation, indicating unsatisfactory performance of the tested circuit.—JZ.

Thermal Noise Measure for Low Temperatures

E. Gurjuoy and A. T. Forrester (The Physical Review, March 15, 1947, pp. 375-376)

A study is made of the possible use of the thermal agitation in a quartz crystal as a low temperature thermometer. It is based on the temperature dependence of the agitation which is responsible for the noise. Conditions to be met for effective measurements are stated and equations are developed which permit estimating the lowest measurable temperature for any desired accuracy. With a Western Electric D-96475 tube and a required accuracy of 2%, the minimum measureable temperature is −456 deg. F or 2 deg. K.—JZ.

Photographic Facsimile Equipment

(Electronic Engineering, London, England, February, 1947, pp. 49-50)

About five photographs per hour, scanned with 100 lines per inch, can be transmitted over a facsimile system designed by the Post Office Research station Dollis Hill, on behalf of Cable and Wireless Ltd., and made by the G. E. Co.

A 108 kc crystal controls the rotation of the picture cylinder which revolves 1,800 times per minute. The same crystal supplies current for the mirror galvanometer which interrupts the scanning light beam at a rate of 1,800 times per second. The amplified amplitude-modulated carrier is rectified and the resultant dc voltage frequency-modulates a beat oscillator between 1.6 and 2 kc.

In the receiver a 10,800 cycle voltage, also crystal-stabilized.

provides a carrier for the received signal in order to raise the center frequency to 12,600 cycles for easy discrimination. The derived signal controls the deviations of a galvanometer mirror which modulates the light beam falling on the photographic film on the receiver drum.—JZ.

Small HF Tubes

G. Alma and F. Franke (Philips Technical Review, Eindhover, Holland, October 1946, pp. 289-295)

The manufacturing technic for small all-glass radio tubes is improved by the use of a cement, with a thermal coefficient of expansion practically equal to that of glass, which is used for joining the bulb to the base. During sealing operation the cement is heated to 450° while the temperature of the electrodes does not exceed 230°, avoiding oxidation and cathode poisoning. Further, the glass is not softened by the bonding and the bulb can be dimensioned with a tolerance of 0.1 mm. The glass base also retains its original shape accurately and the alignment of the contact pins is not disturbed.

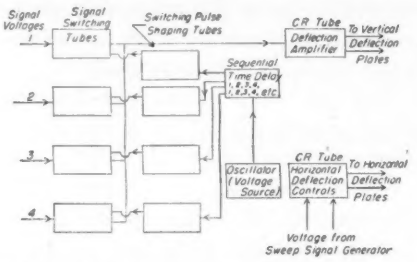
The "A" or "Rimlock" tubes including triode-hexodes, IF pentodes, diode-pentodes, rectifiers, output pentodes, etc., are sealed by this method. The diameter of the tube series is standardized to 22 mm, sufficient for an eight pin base and the 14 watts dissipated in a 9 watt output pentode. The contact pins are uniformly spaced around a circle; correct insertion in the tube socket is assured by a special locking feature which suggested the name "Rimlock" tubes.—JZ.

Four-Channel Switch for CRO

F. S. Replogle and V. M. Albers (The Review of Scientific Instruments, February 1947, pp. 114-117)

In some applications of the cathode ray tube it is desirable to observe or record several signals simultaneously. This may be achieved by rapidly switching the electron beam alternately to trace points corresponding to the different signals.

The schematic diagram is self-explanatory. A push-pull 6SN7 oscillator and a phase shifter provide four sinusoidal, 10,000-cycle voltages with a sequential time lag of 90 deg. The sinusoidal voltages are converted into pulses in 6J6 pulse shaping tubes. Further squaring of the pulses and amplitude regulation are achieved by drawing suppressor grid currents in the following 6AS6 signal


Signal Voltages
Signal Switching Tubes
Switching Pulse Shaping Tubes
CR Tube Deflection Amplifier
To Vertical Deflection Plates
Sequential Time Delay 1, 2, 3, 4, etc
Oscillator (Voltage Source)
CR Tube Horizontal Deflection Controls
To Horizontal Deflection Plates
Voltage from Sweep Signal Generator

Schematic of four-channel switch permitting four signals to be simultaneously recorded by a cathode ray oscillograph

switching tubes. Their combined output is amplified and controls the vertical CR tube deflection.

A complete circuit diagram including dimensions is given. The unit is designed for direct connection to the plates of commercial oscilloscopes using the oscilloscope sweep generator. Two channels have dc signal input only, the two others are designed for dc or modulated ac input up to 100 kc. Individual cycles up to 1 kc may be observed or recorded.—JZ.

Facsimile System for the Press

(Electronic Engineering, London, England, February, 1947, pp. 46-47)

A photographic facsimile equipment developed by Muirhead & Co. for newspaper picture service was recently demonstrated at an exhibition in London.

A picture drum is rotated at either 1 or 2 revolutions per second by a phonic motor and moved along its axis for either 100 or 150 lines per inch. The light beam reflected from the picture is interrupted 7,200 times before impinging on a photocell. Only the 7,200 cycle picture-modulated carrier is amplified and heterodyned with 5,900 cycles to give a 1,300-cycle carrier modulated with the picture signal extending over the range of from 0 to 1,000 cycles which is fed to the transmission line.

In the receiver, the amplified and demodulated carrier controls rotation of a mirror which deflects a beam of light across an aperture and thus regulates the amount of light reaching the photographic material on the receiving drum.

Synchronization is maintained by means of adjustable tuning forks. The two fork frequencies are compared by viewing a suitable image on a cathode ray tube screen. Rotation of the picture indicates necessary adjustments which are made at the receiving fork. Provisions for correct phasing also are made.—JZ.

NH_3 Absorption Lines as Frequency Standards

W. E. Good and D. K. Coles (Physical Review, March 15, 1947, pp. 283-284)

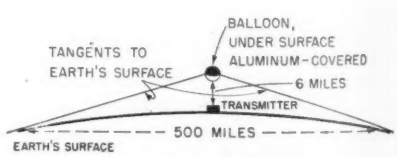
The frequencies of fifty absorption lines in the 19,000 to 26,000 mc range have been established with precision of better than one part in a million or with an accuracy of ±0.02mc. These absorption lines are suggested for use as secondary frequency standards.—JZ.

Increasing Coverage of UHF Transmitters

A. Legrand (La Radio en France, Paris, France, Vol. III, 1946, p. 43)

It is proposed to suspend an "artificial ionosphere" above an ultra short wave transmitter to increase its efficiency. A large balloon appears suitable, if the portion of its surface facing the earth is covered with a reflecting metal layer, aluminum for example.

A narrow beam, emitted in the direction of the balloon and reflected by the metal layer, is spread over an area bounded by the tangents from the balloon to the earth. Assuming line-of-sight propagation, or very short waves, and a balloon floating six miles above the surface of the earth, the diameter of the coverage is 500 miles. For waves of the order of one meter, the reflector may be stationed closer to the earth for a similar coverage. However, in the lower regions air currents may cause the balloon to drift; an elec-



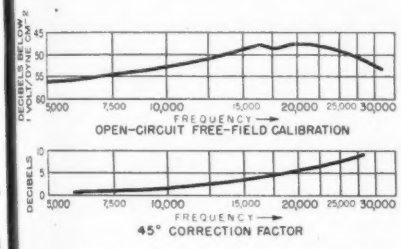
Metallized balloon reflects UHF waves considerably increasing transmitter coverage

tronic control system can be used to maintain it at a desired location. If all the energy emitted is to be reflected, the reflecting surface should be 571 feet in diameter for a 1-degree beam. This is considered feasible, but a much smaller surface works satisfactorily with a comparatively weak transmitter.—*JZ.*

An Ultrasonic Condenser Microphone

T. H. Bonn (The Journal of the Acoustical Society of America, Vol. 18, No. 2, pp. 496-502)

An accurately calibrated standard instrument was required for absolute measurement of sound pressure in the audio and ultrasonic ranges up to 30 kc. Determination of acoustic radiation patterns and calibration of microphones was contemplated.



Characteristics of condenser microphone

The condenser microphone incorporated in the instrument consists of a duralumin electrode mounted opposite a 0.001 in. thick, circular, duralumin diaphragm, having an active diameter of 0.385 in. and stretched almost to its elastic limit. The size of the microphone is reduced to a point where diffraction and phase effects are negligible at audio frequencies and not too serious up to 30 kc. Circular grooves are cut in the face of the electrode and radial slots are milled in the back to compensate for the resonance effects of the diaphragm. High frequency response is raised by provision of a cavity 0.003 in. deep behind the electrode.

It is often necessary that the microphone and preamplifier combination be located at some distance from the amplifying and measuring equipment so that long connecting cables are required. The preamplifier is a cathode follower using a 6AG5 miniature tube and its low output impedance permits the use of cables.

The figure—upper curve—illustrates the open-circuit, free-field calibration of the microphone and —lower curve—the correction factor for 45 deg. incidence as a function of frequency. The output is substantially uniform up to 32 kc and its directional pattern broad up to that frequency. Other response curves are obtainable by variation of diaphragm tension, cavity depth and electrode-diaphragm separation.—*JZ.*

Conditions of Sparking at UHF

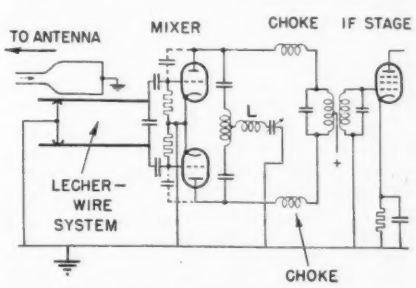
S. Teszner (Compte Rendus, Paris, France, October 1, 1945)

The phenomena accompanying sparking at frequencies in the range of 100 to 1000 megacycles are studied. Conclusions as to the voltage required to fire a tube after extinction to conduct in the inverse direction are presented. It appears that this voltage increases rapidly with frequency.—*JZ.*

Receiver for FM Radio-Telephony at UHF

A. van Weel (Philips Technical Review, Vol. 8, No. 7, pp. 193-198)

The receiver of an experimental frequency-modulated, 48-channel radiotelephone link, operating at approximately 1 m, is described; a bandwidth of about 200 kc is required, the largest frequency deviation is 0.6 mc, the IF 18 mc. Particular attention is given to the push-pull mixing stage, which is made self-oscillating, obviating the



Self-oscillating push-pull mixing stage

necessity for a seprate oscillator and thereby reducing the noise. Further signal-to-noise ratio improvement by a high-frequency amplifier stage would be small and would not warrant inclusion of such a stage.

The local oscillator voltage is generated by the mixer tube. For this purpose an additional inductance, L, is connected in the plate-cathode lead of the triodes which in cooperation with the tube grid-plate capacitance provides positive feedback without interfering with the push-pull connected carrier frequency circuit.—*JZ.*

Radar Echos from the Sea Surface

H. Davies and G. G. Macfarlene (Proceedings of the Physical Society, London, England, Vol. 58, Pt. 6, No. 330, pp. 717-729)

Scattered radar echos from the sea surface blur the regular echo and interfere with the detection of objects on the ocean. In this connection it is of importance to know the reflection and scattering properties of the sea surface and their dependence on the weather and on the angle.

Some theoretical considerations are set forth. The main part of the paper reports the results of quantitative measurements of the radar echos from the surface of the sea at wavelength of 1.25, 3 and 10 cm for different conditions from calm to very rough seas. The experimental procedure is described.—*JZ.*

Diversity System

Z. Jelonek, E. Fitch and J. H. H. Chalk (Wireless Engineer, London, England, February, 1947 pp. 54-62)

The gain of a diversity system is defined as the reduction in transmitter power in decibels secured by the introduction of the diversity system for the same time loss, i.e., the same proportion of time during which the signals are below a specified receiver sensitivity. The possible gain of diversity systems is evaluated by statistical methods for correlated and for independent fading of the wave trains.

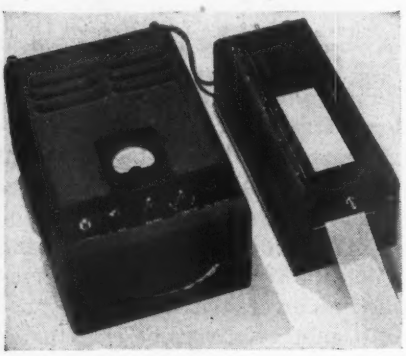
It is proved that the proportion of time loss in a diversity system with independent signals is the product of the proportion of time loss for the constituent signals. Further a greater diversity gain is expected for low permissible time loss. As more signals are added, the gain is increased, but each additional signal gives a reduced increase.—*JZ.*

New Lab and Test Equipment

BREAKDOWN TESTER

(Use Inquiry Card, Mentioning No. 51)

Offering a simple and quick means of testing the voltage breakdown of materials or components, model P-1 voltage breakdown tester has a continuously, Variac-controlled range from 0 to 4000 volts dc. Load is limited to approx. 5 ma over the full range. The unit operates directly from 105-130 volt, 50-60 cycle, ac line. Special test fixtures for mica and paper capacitors are available. Model P-3 breakdown tester, covering range of 0-10,000 volts dc, and equipped with 0-8,000 volt ac outlet, can also be supplied. — *Industrial Instruments, Inc., 17 Pollock Ave., Jersey City 5, N.J.*



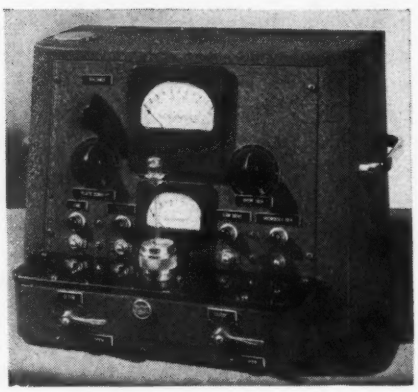
DC AMPLIFIER

(Use Inquiry Card, Mentioning No. 52)

Intended for use with Brush magnetic direct-inking oscillographs, model BL-913 DC amplifier has a voltage gain of 1000 in the range from dc to 100 cps. Sensitivity of the instrument is 1 chart mm/mv, stability 1 chart mm pen drift or less per hour. Permissible input voltage ranges from .001 to 200 volts, the input impedance being 10 megohms. The amplifier operates on 105 to 125 volts, 60 cycles. — *Brush Development Co., 3405 Perkins Ave, Cleveland 14, Ohio.*

ANNOUNCEMENT

For the convenience of readers, all descriptions of new products have been assigned IDENTIFYING NUMBERS. For further information, please use the Prepaid Inquiry Card appearing at page 80 in this issue and *Identify the product by the number assigned to it.*



LEAK DETECTOR

(Use Inquiry Card, Mentioning No. 53)

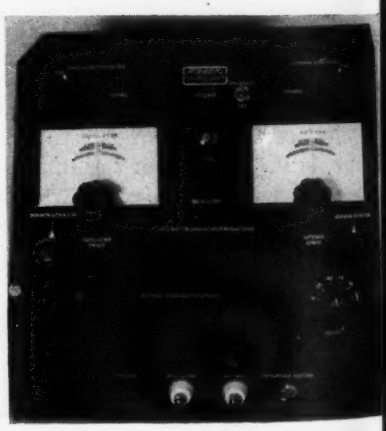
Useful in factory and laboratory for detecting and locating tiny leaks during the manufacture of electron tubes and other evacuated devices, model 722-SS RCA leak detector utilizes a sealed-off high-vacuum ionization gage tube (type RCA-1945) which responds only to hydrogen and is unaffected by other residual gases. In operation the test gas is introduced into the locator through the leak present in the tube or system under test. Presence of hydrogen causes an increase in grid current of the type 1945 tube, which is amplified by a dc amplifier and shown by an upward deflection in the indicating microammeter. The instrument has a self-contained regulated power supply, dc amplifier, all-metal exhaust system, and a vacuum port for checking receiving tubes. Leaks as small as 1x10-5 liter-microns per sec. of hydrogen may be detected. The unit operates on 105-125 volts, 50-60 cycles. — *Tube Dept., Radio Corp. of America, Harrison, N.J.*

ELECTRONIC CIRCUIT TESTER

(Use Inquiry Card, Mentioning No. 54)

Designed for use in measuring any voltage, current, capacitance or resistance encountered in radio receivers and other electronic circuits model 209 electronic volt-ohm-milliammeter imposes very light loading

on dc circuits due to an isolating resistor in the low capacitance h probe. Volts and milliamps. may b measured from 0-1200 in 6 range at an input impedance of 12 megohm (shunted by 6 mmfd) for ac an 15 megohms for dc. Ac voltage fre quency range is from 30 cycles t 300 megacycles. Resistance is covere from .1 ohm to 10,000 megohms in ranges, capacitance from 1-10,00 mmfd in 2 ranges, and 1-1000 mf in 5 ranges. Inductance is measure from 50 mh—100 henries by mean of conversion chart. The instrumen uses 6 tubes. It operates on 105 125 volts, 50-70 cycles, ac and ha a power consumption of 20 watts.— *Hickok Electrical Instrument Co. 10528 Dupont Ave., Cleveland 8, Ohio*



VARIABLE CAPACITOR CHECKER

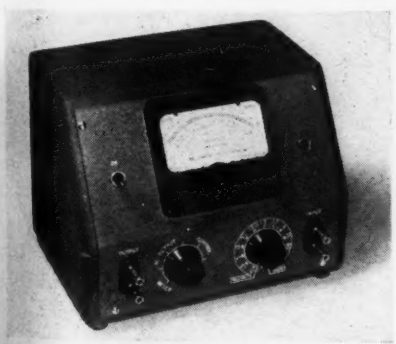
(Use Inquiry Card, Mentioning No. 55)

To insure quality control in th production of variable capacitors thi precision test equipment, consisting of a dual modified Schering bridge with minimum compensators, permits simultaneous electrical indexing of the oscillator section and tracking of the antenna section. The bridge is sensitive to capacitance (±) changes of 0.1 mmfd. It can be calibrated to ±0.1 mmfd, and will retain its calibration to ±0.3 mmfd for four hours even with substantial changes in temperature and humidity.— *Airadio, Inc., Stamford, Conn.*

METER TEST INSTRUMENT

(Use Inquiry Card, Mentioning No. 56)

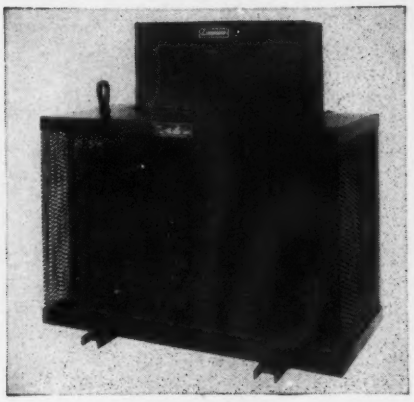
For production testing and calibration of dc meters and for use in laboratories the Marion multi-range tester has a range of 25 microamps. to 10 ma, full scale, the overall accuracy being better than 1/2 of 1%. The instrument includes a regulated power supply, a stepless vacuum tube voltage control using a type 6N7 tube as grid-controlled variable resistor, a decade of .1% accurate wire wound resistors, and an 8 1/2 in. mirror scale, hand-calibrated standard instrument. Basic sensitivity of the standard meter is 10 ma. The unit operates on 110 volts, 60 cycles, ac. — *Marion Electrical Instrument Co., Manchester, N. H.*



AUDIO VOLTMETER

(Use Inquiry Card, Mentioning No. 57)

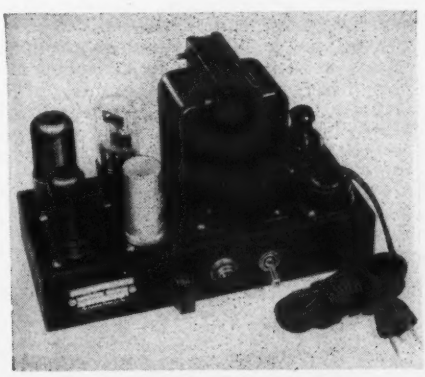
Designed for laboratory applications where high sensitivity and stability are mandatory, such as stage gain measurements, sound level measurements, etc., model 47 audio frequency voltmeter covers a range from 50 microvolts to 500 volts (—84 to +56 VU) in 13 scales of 20 VU, overlapping by 10 VU, each. Suitable for frequencies from 15 cps to 30 kc the instrument, by means of a large feedback factor, has a stability of ±1/2% from 105 to 125 V line voltage, and an accuracy of ±2%. Input impedance is 1 megohm, shunt capacity 12mmfd. Utilizing 8 tubes, the unit operates on 105-125 volts, 50-60 cycle.—*Instrument Electronics 42-15 Douglaston Parkway, Dept. EE., Douglaston, L. I., N. Y.*



HEAVY-DUTY TRANSFORMERS

(Use Inquiry Card, Mentioning No. 58)

Developed for applications requiring heavy current, testing electric furnaces, etc., this line of air-cooled transformers has built-in wiring compartments and terminal boards to facilitate installation. Tap switches capable of handling up to 500 amps. are available for the units. The transformers are obtainable in ratings from 1 to 100 kva, to 600 volts, single phase, three-phase, or 3 to 2 phase. *Lindberg Engineering Co., 2444 W. Hubbard St., Chicago, Ill.*



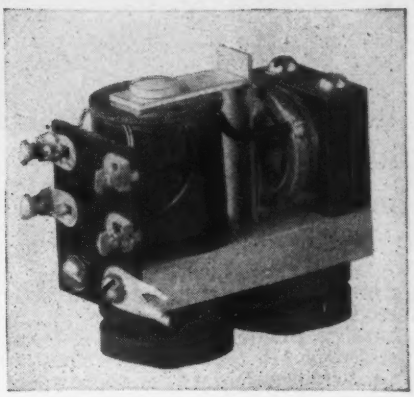
REGULATED POWER SUPPLY

(Use Inquiry Card, Mentioning No. 59)

Intended for laboratory application or as an integral part of electronic equipment requiring constant dc potentials model PAS-2000 is a small regulated power supply providing constant voltage between 130 and 230 volts, dc, up to a 50 ma load and for line voltage variations from 105 to 130 volts ac. Regulation is less than 1% from zero to more than full rated load. Unregulated filament output is 3 amps. at 6.3 volts. Three tubes 6X5, 6L6, and 6SJ7 are used. Power-consumption of the unit is 65 watts at 105 to 130 volt, 60 cycle, ac. —*Pan American Electric Co., 132 Front St., New York 5.*

IRE Engineering Show

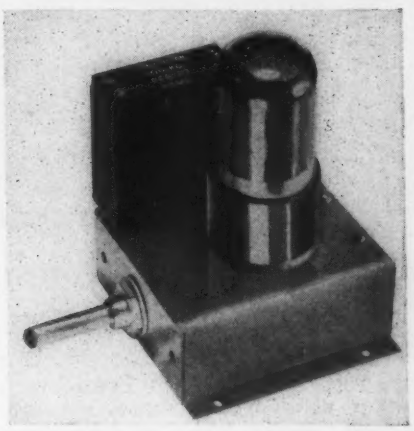
Most of the many new components, parts, and laboratory and test equipment illustrated and described on this and other pages in this issue, were revealed at the IRE Engineering Exhibition staged in Grand Central Palace in conjunction with the Winter Technical Meeting.



MICROPHONE HUMMER

(Use Inquiry Card, Mentioning No. 510)

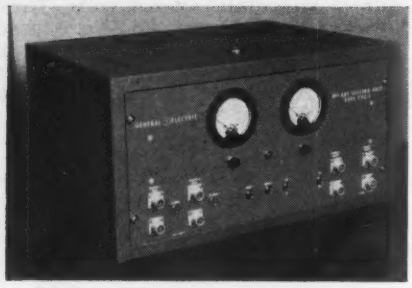
Designed as a power source for measuring bridges type 101 microphone hummer provides an audio frequency signal of 1,000 cycles with an accuracy of better than 5%. Output power is approximately 20 milliwatts at an impedance of either 10 or 300 ohms. Addition of a filter capacitor assures good waveform. Two mounting holes for 10-32 machine screws are provided. The unit weights 7 oz. and operates on a 6 volt dc supply.—*Brown Engineering Co., 4635 S.E. Hawthorne Blvd., Portland 15, Oregeon.*



CALIBRATION OSCILLATOR

(Use Inquiry Card, Mentioning No. 511)

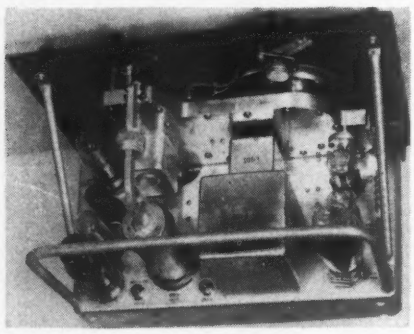
Providing calibration check points every 100 kc at frequencies from 100 kc to 100 mc the type 1088 calibration oscillator has a frequency stability of better than 2 cycles per megacycle per degree centigrade, by use of a low temperature coefficient crystal unit. The unit is equipped with frequency adjusting control for zero beating with WWV or other frequency standard. A power source of either 6 or 12 volts ac is required for the heaters, depending upon whether a 6SN7 or 12SN7 type tube is used.—*Radio Specialty Mfg. Co., 2023 S. E. Sixth Ave., Portland 14, Oregon.*



DECADE SCALER

(Use Inquiry Card, Mentioning No. 512)

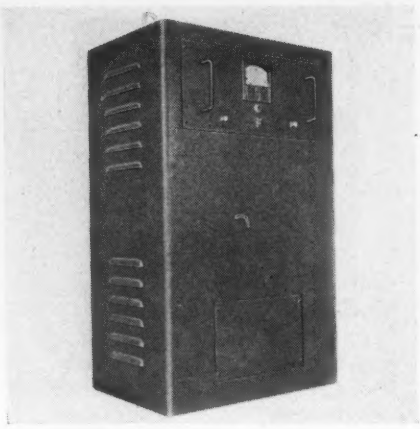
Developed for applications in nuclear research, radioactivity studies, and counting of rapidly recurring phenomena, the GE decade scaling unit type YYZ-1 comprises two channels, each operating as a decade scaler and each having two parallel inputs and outputs. Total scaling factor is 100, but factors of 10,000 or more are available with several units operating in cascade. The unit delivers an output pulse of 40 volts peak, 1 microsecond wide into an impedance of 4700 ohms. It will resolve two pulses, separated 0.1 microesconds. A minimum peak pulse of 10 volts is required for operation. The instrument consumes 150 watts on 105-125 volts, 50/60 cycles, ac. — *Electronics Dept., General Electric Co., Syracuse, N.Y.*



MICROWAVE TEST EQUIPMENT

(Use Inquiry Card, Mentioning No. 513)

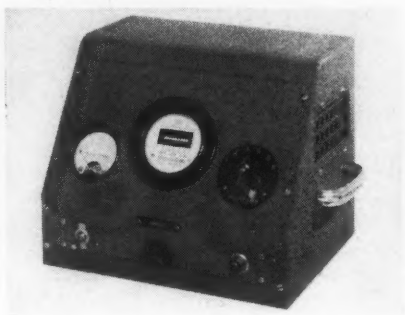
Test set, Type H-10, is a combination of standard signal generator, power meter and frequency meter, developed for field or laboratory measurements of receiver and transmitter performance in the frequency range of 23,500-24,500 mc. The rf oscillator can produce either CW or pulsed FM. Trigger voltage for the frequency modulator is supplied by the video amplifier, fed by crystal detector or external video pulse. Rate of frequency sweep and phase are adjustable. The set includes a calibrated attenuator, compensated thermistor power-monitoring bridge and meter system, waveguide switch, and microwave plumbing components. Sensitivity, bandwidth, frequency, recovery time, and overload characteristics may be measured on a receiver. The unit is self-contained and operates on 110 volt, 60 cycle, ac. —*Aircraft Radio Corp., Boonton, N.J.*



AUTOMATIC VOLTAGE REGULATORS

(Use Inquiry Card, Mentioning No. 514)

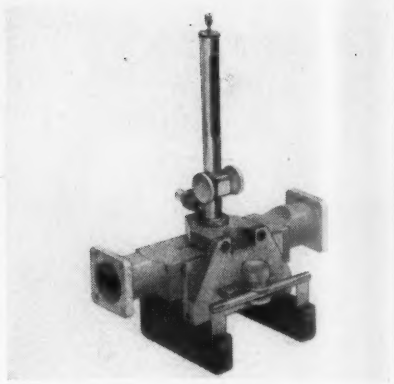
The entire line of Stabiline voltage regulators, formerly known as SECO automatic voltage regulators, has been re-engineered to incorporate new electronic and mechanical refinements of the control circuit and power elements. New characteristics include faster detection of line voltage variations, non-microphonic performance, etc. All removable components are of the plug-in type. Wiring is concealed with no exposed "live" parts. The power elements have been made more compact and are fitted in smaller cabinets. Other characteristics of the old-type units have been retained. — *Superior Electric Co., 1094 Church St., Bristol, Conn.*



FREQUENCY METER

(Use Inquiry Card, Mentioning No. 515)

Useful for checking audio oscillators, frequency convertors, radar equipment, and calibrating less accurate frequency meters, the model 39-VTF vacuum tube frequency meter measures frequency in 6 specific bands from 400 to 3600 cps. with an accuracy of ±0.25% of the frequency being measured. Multivibrators divide the incoming frequency by factors of 1,2,3,4,6 or 9, depending on the position of the multiplier switch, and indicate the result on a standard, reed-type, 400 cycle meter. Input sensitivity of the instrument is 500,-000 ohms, using the regular line current for power supply. An input control permits use from 100 to 350 volts. — *J-B-T Instruments, Inc., 441 Chapel St., New Haven, Conn.*



MICROWAVE TEST EQUIPMENT

(Use Inquiry Card, Mentioning No. 516)

Outstanding in a complete line of PRD microwave test equipment, which includes attenuators, directional couplers, frequency meters, and waveguide-to-coaxial adapters, etc., are the slotted section and probe combinations, which use a friction-driven probe carriage, supported by spring-loaded ball bearings, rolling in precision-ground grooved runways made from hardened tool steel. These features combine to give the carriage a smooth and accurately linear motion without slope, backlash, or play. There is complete freedom from wear, and instrument accuracy is maintained indefinitely. The probe shown covers the frequency range from 1000 to 10,000 mc/sec and is used with all slotted sections operating in this frequency range. — *Polytechnic Research and Development Co., 66 Court St., Brooklyn 2, N.Y.*

MEGHOM METER

(Use Inquiry Card, Mentioning No. 517)

Designed particularly for high speed testing of condenser leakage, insulation resistance, and insulation measurements in production and inspection of components, type L-2A megohm meter covers a range from 1 to 100,000 megohms on 4 multiplier ranges of 1, 10, 100, and 1000. The range may be extended to 500,000 megohms by means of an external 1000 volt dc supply. Accuracy is within ±3% of full scale. A balanced tube circuit and regulated power supply assure stability. — *Industrial Instruments, 17 Pollock Ave., Jersey City 5, N. J.*

ANNOUNCEMENT

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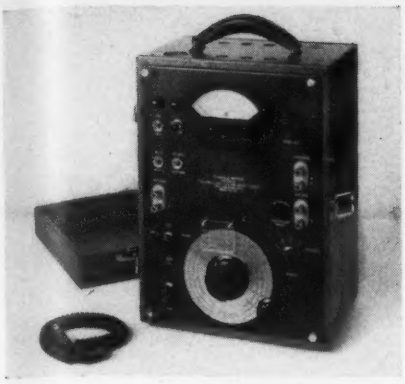


IMPEDANCE METER

(Use Inquiry Card, Mentioning No. 518)

Designed for impedance and phase angle measurements over a frequency range of 30 to 20,000 cps the type 310-A Z-angle meter finds application in electrical, audio, and electro-acoustic measurements. Balance is accomplished with a single dial, direct-reading in impedance, and the phase angle of the unknown impedance is indicated on the direct-reading meter. The "D" of capacitors and the "Q" of inductors may also be measured. Impedance range of the instrument is from 0.5 to 100,000 ohms, accurate to within ±1% over the greater portion of the range. Phase angle readings are accurate within ±2 degrees. Effective range for capacity is from 1,000 mmfd to 10,000 mfd, for inductance from 5 microhenries to 500 henries.—*Technology Instrument Corp., 1058 Main St., Waltham, Mass.*

MULTITESTER

(Use Inquiry Card, Mentioning No. 519)

Having a dc sensitivity of 5000 ohms per volt, model 449A multitester is especially effective in measuring low-current circuits where loading must be held at a minimum. It is provided with a Germanium crystal rectifier permitting ac measurements from 30 cps to 50 kc. The 3-in. square meter is accurate to 2%; the metallized voltage multipliers have a tolerance of 1%. Four ac-dc voltage ranges to 1000 volts, four current ranges to 1000 ma, and four resistance ranges are provided. — *Radio City Products Co., 127 W. 26 St., New York 1.*

FIELD INTENSITY METER

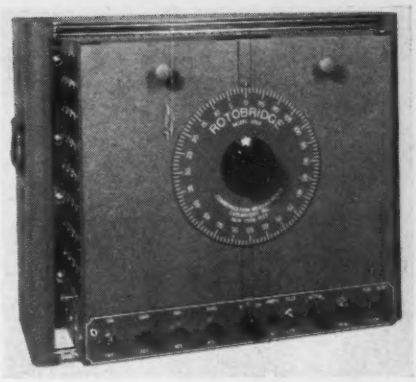
(Use Inquiry Card, Mentioning No. 520)

Purpose of the NMA-4 noise and field intensity meter is to locate and measure radio and uhf noise, and to measure the field intensity of carriers from AM, FM and television transmitters. The single band, wide range rf unit provides noiseless tuning from 88 to 400 mc. Voltage range of the instrument is from 1 to 100,000 microvolts, the sensitivity being not less than 2 microvolts at any frequency within its range. Selectivity is approximately 210 kc bandwidth at 6 db down. In operation the rf signal is picked up by an adjustable dipole and its location determined by antenna position. The dipole is then replaced by a loop probe antenna, and signal is fed through a 95-ohm transmission line to the input of the instrument. — Stoddart Aircraft Radio Co., 6644 Santa Monica Blvd, Hollywood 38, Cal.

ELECTRONIC GENERATOR

(Use Inquiry Card, Mentioning No. 521)

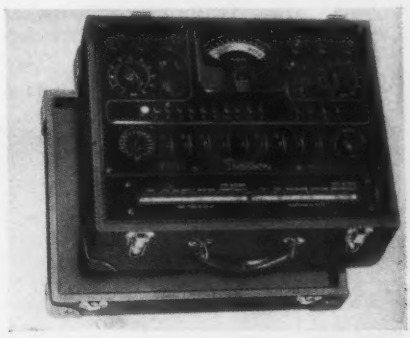
Intended for research laboratories and manufacturers requiring an ac power source model 1430 variable frequency generator consists of a VFO followed by several driver stages, and an output stage. Power output of the unit is 1400 watts at 120 volts rms with a load of unity power factor. Output voltage is adjustable from 0-140 volts with regulation not exceeding 1% from no load to full load. Frequency range varies from 50 to 5000 cycles, waveform distortion being less than 10% at full load. Any 60 cycle, single phase source between 208 and 260 volts ac, capable of carrying 3.5 kw load will serve as power supply. — *Communication Measurements Laboratory, Inc., 120 Greenwich St., New York 6.*



AUTOMATIC CIRCUIT INSPECTOR

(Use Inquiry Card, Mentioning No. 522)

All types of electronic equipment may be checked for circuit wiring, errors, and proper resistance values with the model 1010 Rotobridge high speed production tester. As sets come off the production line they are compared against a standard set of the same type by means of the Rotobridge which connects equivalent circuits of sample and production unit as two arms of a specialized Wheatstone bridge. A panel switch permits setting the overall tolerance of the line unit to 5%, 10% or 20% with an accuracy of 10% for the setting. Units not meeting the tolerance are rejected by the bridge. The instrument is designed for 24 hour-day operation and permits quick shifting of the equipment to be tested. It is available as standard rack and panel job or in bench cabinet.—*Communication Measurement Laboratory, 120 Greenwich St., New York 6.*

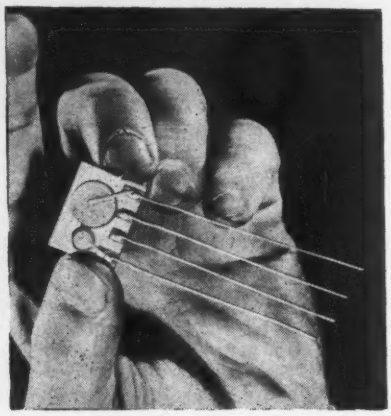


TUBE TESTER

(Use Inquiry Card, Mentioning No. 523)

Incorporating a new roll chart for quickly identifying tubes and setting controls, model 330 mutual conductance tube tester checks tubes with voltage applied over the entire operating range under similar conditions as in a radio receiver. Ten push-button switches and nine rotating switches of six positions each, provide a large number of combinations in tube element and circuit selection. A 4½-in. rectangular meter has quality and "percentage of mutual conductance" scales. The instrument is available as counter or portable model.—*Simpson Electric Co., 5200-18 W. Kinzie St., Chicago 44, Ill.*

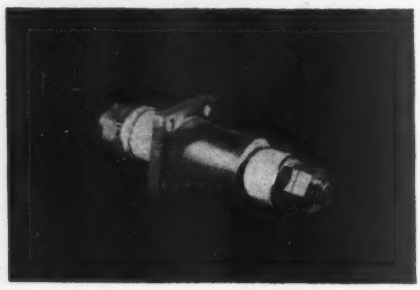
Parts for Design Engineers



PRINTED CIRCUIT COUPLER

(Use Inquiry Card, Mentioning No. 524)

First commercial application of printed electronic circuits the "Couplate" interstage coupling circuit combines into one compact unit the plate load resistor, grid resistor, plate by-pass capacitor and coupling capacitor. Only four soldered connections are required by the Couplate instead of the usual eight or nine. Each unit is an integral assembly of the new "Hi-Kap" ceramic miniature capacitors and resistors closely bonded to a steatite ceramic plate and mutually connected by means of metalic silver paths "printed" on the base plate. Standard values are used for the coupling components, but special values are available.—*Centralab, Div. of Globe-Union Inc., Milwaukee, Wis.*



RF BY-PASS CAPACITOR

(Use Inquiry Card, Mentioning No. 525)

Primarily intended for use as power line terminal to by-pass radio frequency currents on industrial heating and similar equipment, the type 2373 feed-thru, Ceramicon capacitor is rated at 1000 volts dc operating with the center feed terminal having a carrying capacity of 200 amps. Rugged design is secured by using a .109 in. wall thickness dielectric soldered into a silver plated brass bushing with mounting flange. The unit is available in capacities of 250, 650, 1000, and 10,000 mmfd.—*Erie Resistor Corp., Erie, Pa.*

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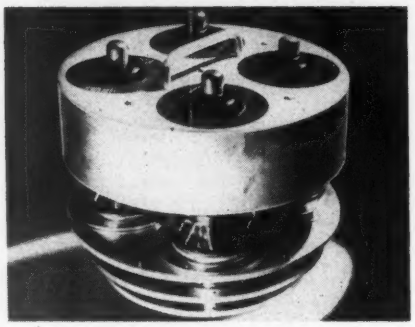
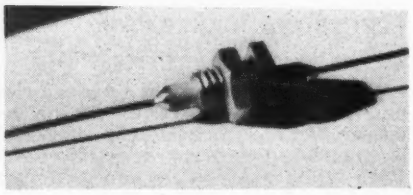


TRANSMITTING TRIODE

(Use Inquiry Card, Mentioning No. 526)

Suitable for effective use in the uhf region as well as at lower frequencies, the Eimac 3X12500A3 medium-mu, forced-air cooled triode permits production of high power at low plate voltage through close electrode spacing in a multi-unit design. As a push-pull grounded-grid 110 mc FM amplifier, a pair of 3X12500A3's will deliver a useful output over 50 kw at a plate voltage of 3700 v. Amplification factor of the tube is 20, transconductance being 80,000 micromhos. Filament current is 192 amps. at 7.5 volts.—*Eitel-McCullough, Inc., San Bruno, Calif.*



FEED-THROUGH CAPACITOR

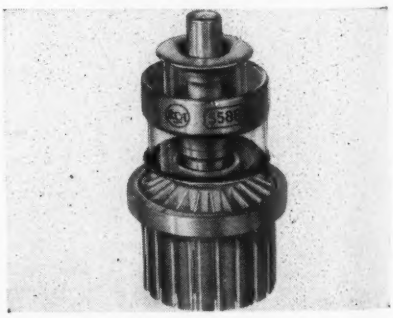
(Use Inquiry Card, Mentioning No. 527)

Soft wire feed-thru Ceramicon capacitors, type 363, have been developed which have advantages in certain applications over the company's stiff-wire feed-through capacitors. The units have #20 soft wire pigtails extending 1 5/16 in. from either end to permit bending of the ends for point-to-point wiring. Type 363 is available in capacities from 7 to 1500 mmfd.—*Erie Resistor Corp., Erie, Pa.*

PLASTIC FILM CAPACITORS

(Use Inquiry Card, Mentioning No. 528)

A line of "Plasticon Glassmikes" capacitors using type L plastic film and having high rf current carrying characteristics, has been developed. During a demonstration a 150 mmfd Plasticon LSG Glassmike, measuring ⅜ in. OD x 1-3/16 in. long, was operated at 1 mc at 5 amps. At the end of 8 hours of continuous operation temperature rise was about 5°C. DC rating of the unit, which has a "Q" of more than 5,000, is 5000 volts. An equivalent upright mica capacitor occupies more than 50 times the volume. The capacitors can be operated through a temperature range of —60 to +85°C. Absorption and insulation resistance compares with Polysterene film units. Humidity and immersion have no permanent effect.—*Condenser Products Co., 1369 North Branch St., Chicago 22, Ill.*



UHF POWER TRIODE

(Use Inquiry Card, Mentioning No. 529)

Having a maximum rated plate dissipation of 200 watts, the RCA-5588 is a compact, forced-air cooled power triode that can be operated with full plate voltage and plate input at frequencies as high as 1200 megacycles. The tube features a coaxial electrode structure designed especially for use with circuits of the radially spaced coaxial-cylinder type. Good isolation of plate from cathode makes the 5588 suitable for grounded-grid circuits. Amplification factor of the tube is 23, filament voltage 6.3 v., and filament current 2.5 amps. Required air flow for maximum plate dissipation is 10 cfm min.—*Tube Dept., Radio Corp. of America, Harrison, N. J.*

Fieldcrest
THERMOSTATIC BLANKETS

Another use for EDISON sealed-in-glass electrical controls

WHEN Fieldcrest Mills (Division of Marshall Field & Company, Inc.), makers of the famous "Fieldcrest" textiles, decided to add an electrically warmed blanket to their line, they engaged EDISON to engineer and produce in quantity the necessary electrical control. They specified that the control must be simple, silent, smooth, trouble-free, and rugged.

Edison met the specifications with a sealed-in-glass electrical control especially designed for the automatic regulation of blanket warmth.

Simple, Silent, Smooth

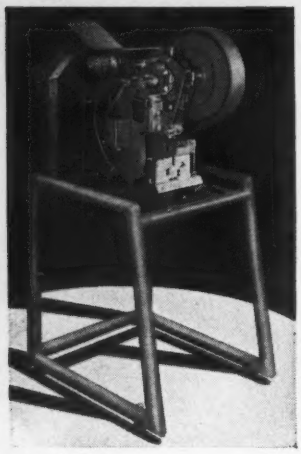
The EDISON sealed-in-glass electrical control for "Fieldcrest" thermostatic blankets has few component parts . . . it's *simple!* It doesn't buzz or click . . . it's *silent!* It has a small on-off differential . . . it's *smooth.* It's *trouble-free* because the sealed-in-glass principle prevents corrosion . . . keeps out dust and dirt. It's *rugged* and consistent in operation.

Have YOU a Problem EDISON Sealed-in-Glass Controls Can Solve?

Your electrical control problem may be quite different. Possibly it has to do with current limiting, voltage control, or cathode protection. Whatever it is, if you need cooperation in the engineering and quantity production of sealed-in-glass controls, let's discuss your problem.

THOMAS A. EDISON, INCORPORATED
INSTRUMENT DIVISION
70 Lakeside Avenue, West Orange, New Jersey

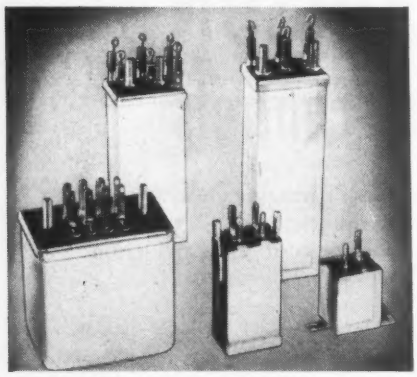
EDISON Sealed-in-glass electrical controls



AUTOMATIC TERMINAL MACHINE

(Use Inquiry Card, Mentioning No. 538)

Production speeds in excess of 3,300 electrical connections per hour are achieved by the AMP automatic machine which utilizes a continuous strip of solderless terminals and a completely automatic crimping cycle. The mechanism is actuated by inserting one end of a wire and a solderless terminal is automatically installed. The machine handles solid or stranded wire in sizes 22 to 10.—*Aircraft-Marine Products Inc., 1609 North 4th St., Harrisburg, Pa.*



POTTED THERMISTORS

(Use Inquiry Card, Mentioning No. 539)

Containing various combinations of thermally sensitive resistors, these "potted" thermistors provide a new type of circuit element in which electrical resistance varies with changes in temperature for use in temperature measurements and compensation, slow actuators, protective devices or in shaping networks, voltage regulators, compressors and expanders, etc. Made of semi-conductors having large negative coefficients of resistance, the thermistor elements may be controlled either by changes in ambient temperature or heating by the circuit in which used. The elements themselves are available in disc, rod, and bead types.—*Western Electric Co., Inc., 195 Broadway, New York 7.*

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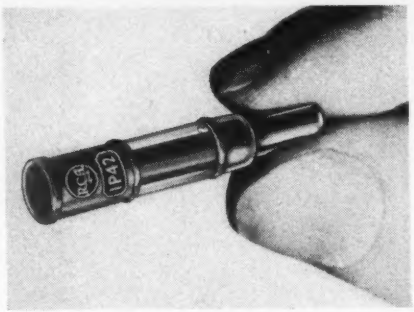
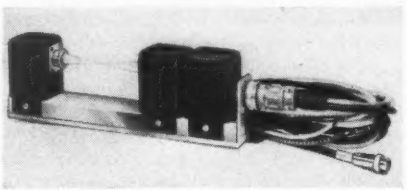


CAPSULE-SIZE PHOTOTUBE

(Use Inquiry Card, Mentioning No. 540)

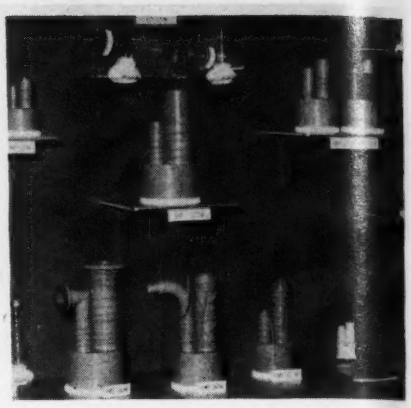
Having a max. diameter of ¼ in. and overall length under 1-13/32 in., the RCA-1P42 is the smallest phototube ever offered commercially for applications in business and industry. It is activated by light entering through a tiny window at the larger end. Its small size makes it especially suitable for animated electric advertising signs. Spectral response of the 1P42 is of the blue-sensitive type S-4, the sensitivity at 4,200 Å — the wavelength of max. response — being .02 microamps./watt. Max. anode-supply voltage is 150 volts dc or peak ac, average cathode current being 0.4 microamps. Ambient temperature should not exceed 75° C. — *Radio Corp. of America, RCA Victor Div., Camden, N. J.*



PHOTOELECTRIC COUNTER

(Use Inquiry Card, Mentioning No. 541)

For counting pills, buttons, hardware and other small or irregularly shaped items photo-electric actuator model 600 has a beam approximately 1/16 in. wide, and will respond to changes in light level as small as 20%. Since complete interruption of the light beam is not required, it has been possible to count objects as small as .01 in. with accuracy. The actuator provides the negative pulses required for operation of the company's electronic counters and is designed to count at rates up to 30,000 per minute. — *Potter Instrument Co., 136-56 Roosevelt Ave, Flushing, N.Y.*



MINIATURE PUMPS

(Use Inquiry Card, Mentioning No. 542)

VMF series miniature, all-metal, oil fractionating diffusion pumps include a number of water- and air-cooled types capable of reaching pressures of 10^{-6} mm Hg. and lower, with a wide range of pumping speeds. Because of the compact size the units are well adapted for use on most moderately sized vacuum chambers. Octoil is the recommended pumping fluid.—*Distillation Products, Inc., 755 Ridge Road West, Rochester 13, N. Y.*

HIGH VOLTAGE INSULATION

(Use Inquiry Card, Mentioning No. 543)

By combining the properties of Geon polyvinyl chloride and Hycar oil resistant American rubber excellent oil and grease resistance is obtained in addition to good insulating properties for high tension work. "Cohardite" linesmen's pliers using durable grips made of this insulating material have been tested at 28,000 peak volts.—*Connecticut Hard Rubber Co., New Haven, Conn.*

WIRE MARKERS

(Use Inquiry Card, Mentioning No. 544)

E-Z-Tab is a new feature incorporated in E-Z-Code wire markers which permits removal of a single marker from the card without disturbing any of the remaining markers. By using the tab the marker will not stick to the fingers, and dirt and contamination is eliminated assuring maximum adhesive contact. Over 325 stock code markers meet most requirements. Special code combinations can be supplied.—*Western Lithograph Co., Los Angeles 54, Cal.*

Amphenol

ALL-WAVE ANTENNA

GETS ALL THREE!

BC

SW

FM

Purchasers of modern radios deserve good reception on all three bands—standard broadcast, short wave and frequency modulation. Until Amphenol engineers perfected this new all-wave unit, the only way to achieve this was to install three separate antennas, a costly and unsightly solution.

The FM section of this new 3-way antenna is a horizontally polarized dipole. It operates most efficiently between 88 and 108 mc.

A 65-foot length of Amphenol Polyethylene covered copper wire serves as the standard broadcast and short wave antenna. The polyethylene covering minimizes precipitation static and assures long life.

A specially designed series M derived low-pass filter automatically switches the energy from the proper antenna to receiver input.

Installation is simple. The mounting is a 1-inch steel mast 5-feet in length. All hardware is included. A guy clamp bolted to the mast provides for tripod guying.

Vinyl-jacketed Amphenol 52 ohm coaxial transmission line serves as a low-loss lead in and eliminates interference from transmission line pickup. Noisy areas are not a problem with this antenna.

In a comparative test with the best available standard double doublet (with matching transformer) the Amphenol All-Wave Antenna proved far superior in gain—as well as being interference free.

Write for complete technical data, or see your jobber for full information.

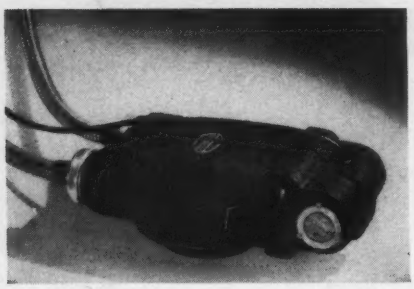
AMPHENOL ALL-WAVE ANTENNA UNIT INCLUDES:

- ★ FM dipole with molded phenolic weatherproof filter housing
- ★ Steel mast 5-feet long with guy clamp and adjustable insulator
- ★ 50-feet Amphenol RG-5/U 52 ohm coaxial cable
- ★ Antenna wire polyethylene covered
- ★ Built-in M derived network

AMPHENOL

AMERICAN PHENOLIC CORPORATION
CHICAGO 50, ILLINOIS

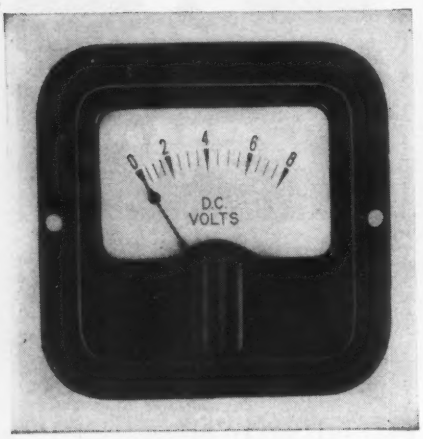
COAXIAL CABLES AND CONNECTORS • INDUSTRIAL CONNECTORS, FITTINGS AND CONDUIT • ANTENNAS • RF COMPONENTS • PLASTICS FOR ELECTRONICS



DIAGNOSTIC X-RAY TUBE

(Use Inquiry Card, Mentioning No. 545)

Efficient for applications in fluoroscopy, spot film radiography and serialography, the Aeromax "15" shockproof X-ray tube is of the stationary anode diagnostic type, especially designed for under-table service. An air-circulator is available as optional attachment to increase rate of heat dissipation and permit continuous operation. Insert tubes are heavy anode Pyrex glass types with 20° linear focal spots. They are supplied in single and double focus models with a choice of focal sizes and combinations. Maximum voltage is 110 PKV for fullwave and 100 PKV in halfwave or self-rectified service. Maximum energy depends on service used and focal spot size. Typical value for fluoroscopy is 5 ma. at 100 PKV continuous (with air-circulator).—*Machlett Laboratories, Inc., Springdale, Conn.*



MOVING VANE TYPE METERS

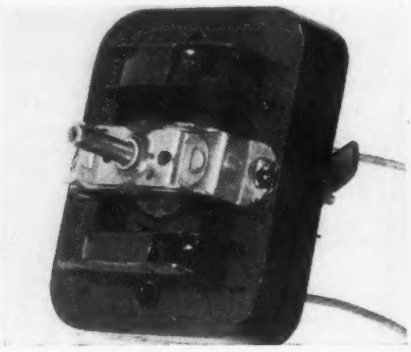
(Use Inquiry Card, Mentioning No. 546)

Efficient under conditions of severe vibration, the pointer oscillation of these moving vane type ammeters and voltmeters has been reduced to a minimum by means of high torque, light weight, balanced movements mounted in the field of a strong permanent magnet. The broad, easy-to-read scales have up to 80 degrees of arc. Meters are supplied in 2-in. and 2½-in. sizes in round or square beaded or top flange cases. Ranges very from 0-1 to 0-100 amperes and from 0-3 to 0-150 volts. A number of zero-center scales are also available. Weight of the units is 4½ ozs. —*United States Gauge Div., American Machine and Metals, Inc., Sellersville, Pa.*

PHOTOFLASH TRANSFORMER

(Use Inquiry Card, Mentioning No. 547)

The PF-1 photoflash transformer is intended for use in power supply circuits for charging capacitors employed with multiple flash tubes. It can be used in conjunction with flash tubes of the Amglo type or with Sylvania type tubes in a suitable circuit. The unit is supplied in case G-2 having dimensions of 2¾ x 2⅛ x 2½ in. high, and is mounted on 3¼ in. centers. Weight is approximately 2 lbs.—*United Transformer Corp., 150 Varick St., New York 13.*



FRACTIONAL HP MOTORS

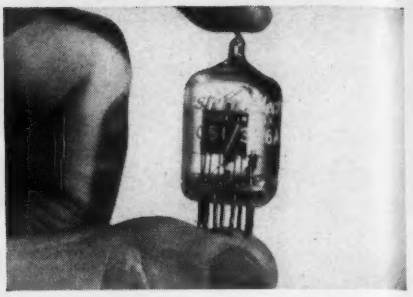
(Use Inquiry Card, Mentioning No. 548)

Suitable for many applications where good starting torque requirements are needed, these rugged fractional HP motors are of the single phase, shaded pole induction type. Constant speed is maintained through use of a new shading design. The dual motor coils of ample turns and impregnated against moisture will operate continuously with very low temperature rise. Bearings are of the self-aligning, self-lubricating type.—*Eastern Electronics Corp., 41 Chestnut St., New Haven, Conn.*

MINIATURE TRIODE

(Use Inquiry Card, Mentioning No. 549)

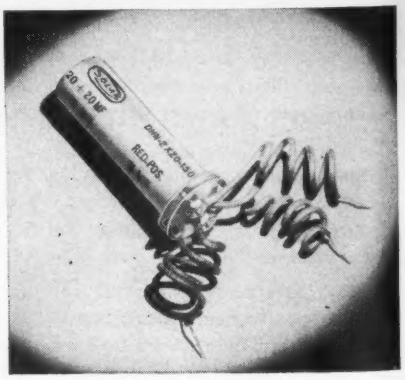
Intended for use in amplifier, mixer, oscillator, multivibrator and clamp circuits the 2C51/396A 9-pin miniature double triode is capable of performing in very high speed trigger circuits and has a useful frequency range extending from low frequencies through the vhf range. As an oscillator the tube has been used at frequencies as high as 800 mc. Separate cathode-grid-plate structure permits simultaneous operation of each triode section in different circuits. Maximum plate potential of the tube is 300 volts, plate dissipation per section 1.5 watts, and plate current 18 ma. Heater voltage is rated at 6.3 volts, ac or dc, with a heater current of .3 amps.—*Western Electric Co., Inc., 195 Broadway, New York 7.*



NYLON LOCK-NUTS

(Use Inquiry Card, Mentioning No. 550)

Primarily intended for the aircraft and electronic industries, "N" series nylon lock-nuts are made in No. 4, 6, 8, and 10 sizes and utilize a hexagonal molded nylon insert as a locking means. Also to be available are "W" series nuts which utilize a standard hexagon nut with a nylon wedge inserted in one of the hex faces. The nut has high torque characteristics and will be manufactured in all sizes from ¼ in. up. —*The Nylok Corp., 475 Fifth Ave., New York 17.*



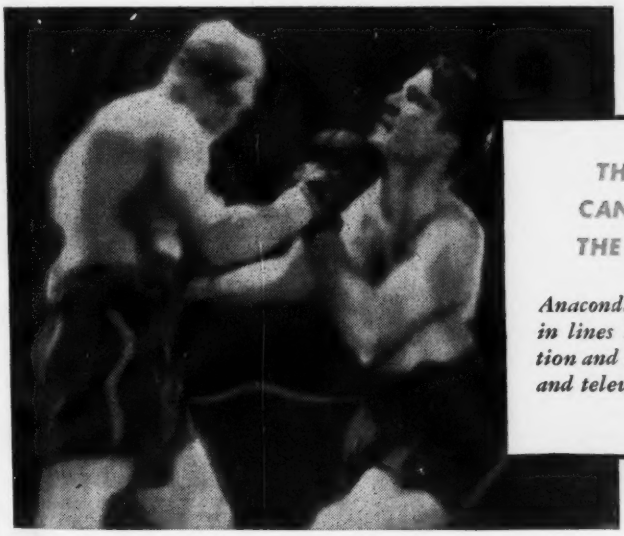
ELECTROLYTIC CAPACITORS

(Use Inquiry Card, Mentioning No. 551)

An easy-mounting stud-disc and plate mounting device is being used on all Solar type DH universal replacement dry electrolytic capacitors. This design permits secure clamping of the capacitor to the set chassis in a vertical position when used to replace old screwbase or twist-prong electrolytics. No additional holes are required. For flat under-chassis mounting, the stud-disc is removed and the unit is fastened with a universal mounting strap provided with each capacitor.—*Solar Mfg. Corp., 285 Madison Ave., New York 17.*

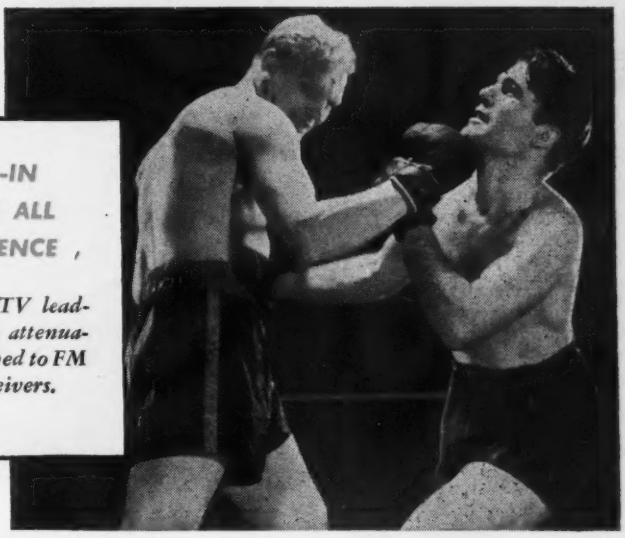
Anaconda—OUT FRONT IN TELEVISION LEAD-IN LINES

TYPE ATV standard FM and television lead-in lines



THE LEAD-IN CAN MAKE ALL THE DIFFERENCE ,

Anaconda Type ATV lead-in lines have low attenuation and are matched to FM and television receivers.



Anaconda Type ATV* lead-in lines are designed for minimum signal loss and maximum freedom from distortion in FM and television reception. The satin-smooth polyethylene insulation of Type ATV line sheds water readily, thus avoiding subsequent impedance discontinuities. This material also has exceptionally high resistance to corrosion.

There is a wide selection of correctly engineered lead-in lines for 75, 125, 150 and 300 ohms impedance unshielded and 150 ohms shielded—each designed to fulfill the exacting requirements of wide-band reception.

*An Anaconda Trade-Mark

47440

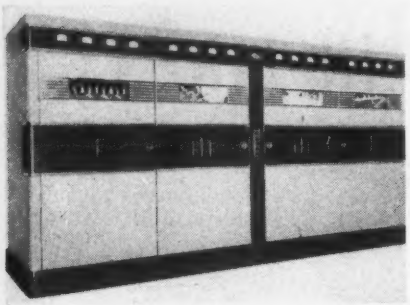
ANACONDA RESEARCH BRINGS YOU A COMPLETE LINE OF HIGH-FREQUENCY CABLES OF ALL TYPES

Make Anaconda your headquarters for high-frequency cables. Write for a useful folder containing electrical and physical characteristics of the complete line of Anaconda coaxial cables. Also, ask for a bulletin giving the characteristics of Type ATV lead-in lines. Address: Anaconda Wire and Cable Company, 25 Broadway, New York 4, New York.

ANACONDA from mine to consumer

ANACONDA WIRE AND CABLE COMPANY

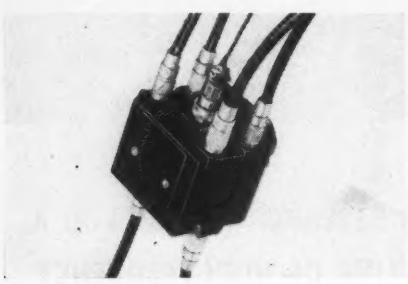
Communications Components



AM TRANSMITTERS

(Use Inquiry Card, Mentioning No. 552)

Completing its AM line from 250 to 10,000 watts power, regular production has been established on the Raytheon RA-5 and RA-10 five and 10 kw AM transmitters. The flexible units allow either manual or automatic control at the centralized control panel in addition to manual or automatic control through a transmitter control console. The transmitters consist of four compartments of vertical chassis type construction, large enough to permit easy servicing. Frequency response for both units is essentially flat from 30 to 10,000 cps, distortion is held to less than 3% at 65% modulation, and noise level is 60 db below 100% modulation. *Broadcast Equipment Div., Raytheon Mfg. Co., 7517 N. Clark St., Chicago, Ill.*



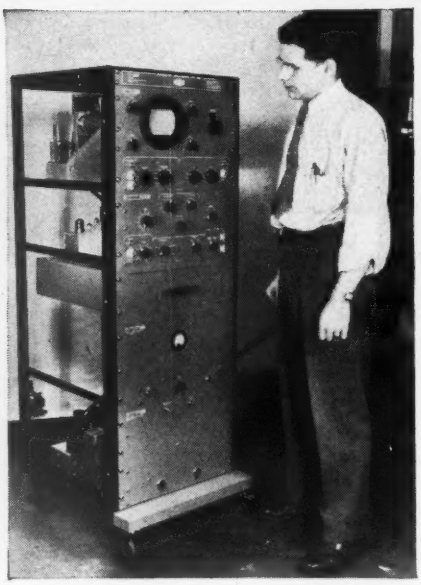
ALTIMETER TRANSFER SWITCH

(Use Inquiry Card, Mentioning No. 553)

Making possible the use of a single pair of antennas for operation of two separate radar altimeters, this new-type (AVA-68) coaxial transfer switch is a double-pole double-throw device which can be operated from any remote position in the aircraft. A two-wire power cable is used to connect the switch assembly to a conventional toggle switch in the cockpit. A rotor mechanism in the transfer switch makes connection between antennas and the desired altimeter; it turns off automatically the unused altimeter. The AVA-68 switch may also be used for any equipment using 52 ohm coaxial lines.—*Radio Corp. of America, RCA Victor Div., Camden, N. J.*

ANNOUNCEMENT

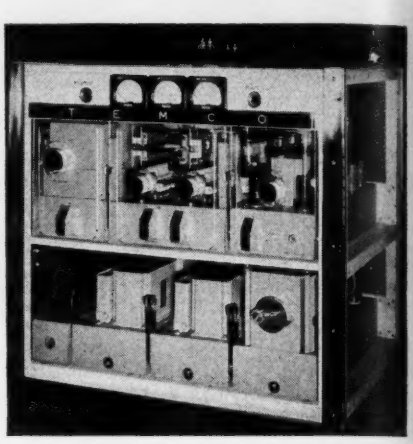
For the convenience of readers, all descriptions of new products have been assigned IDENTIFYING NUMBERS. For further information, please use the Prepaid Inquiry Card appearing at page 80 in this issue and *Identify the product by the number assigned to it.*



OSCILLOGRAPH

(Use Inquiry Card, Mentioning No. 554)

Consisting of four units the Type 280 cathode-ray oscillograph provides means for recording the duration and shape of waveforms contained in composite television signals, according to FCC standards. The indicator used is the Type 5RP-A CR tube. The Du Mont recording camera or projection lens may be attached to the mounting bezel. Vertical deflection provides attenuation between 1:1 and 1000:1 and frequency response within 3 db from 10 cps to 10 mc. Horizontal deflection uses a saw-tooth time-base generator variable from 1-15,000 microseconds and with a deflection of at least 4 in. Time base can correspond with any horizontal line in either or both of the interlaced fields. The calibrating generator measures length of sweep with a writing-rate calibrator for small time intervals, and also has calibrated delay ranges for intervals up to 1000 micro seconds. Type 280 operates on 115 volt, 50-60 cycle. —*Allen B. Du Mont Laboratories, 2 Main Ave., Passaic, N. J.*



TRANSMITTER

(Use Inquiry Card, Mentioning No. 555)

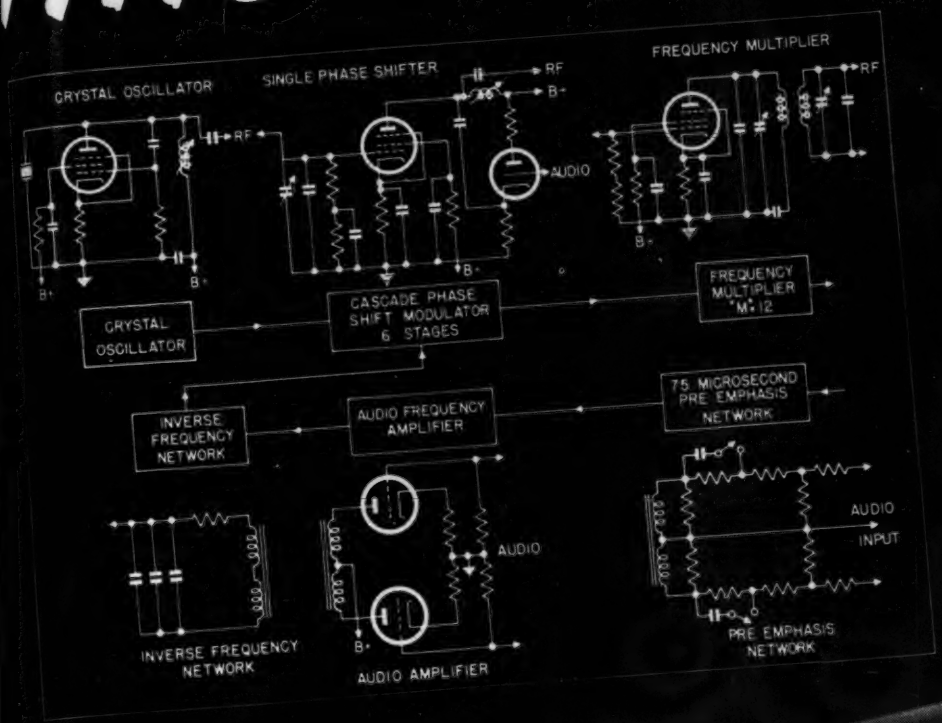
Embodying a new concept of transmitting design through sectionalized construction Temco Model 150-RA transmitter comprises a series of small plug-in chassis with eight basic units permitting various combinatons to fill a wide range of technical requirements. Illustration of the 150-RA transmitter, housed in transparent plexiglass cabinet at the IRE-convention, shows some of these basic units. In the top shelf—left is the variable frequency oscillator and crystal oscillator; center-wide band frequency multipliers for six bands and final amplifier; at right—AM speech equipment and modulators. In the bottom shelf: Left—low voltage supply for FM multipliers; center—high voltage supply for modulators, right—high voltage supply for final amplifier. Also available separately is a narrow band fm unit using phase modulation of a crystal controlled oscillator, and inexpensive plug-in crystal controlled oscillator, frequency multiplier stage, and final amplifier. Production units are furnished with metal panels and cabinets. — *Transmitter Equipment Mfg. Co., 345 Hudson St., New York 14.*

CRYSTALS

(Use Inquiry Card, Mentioning No. 556)

Expensive, power-consuming ovens in set design can be eliminated in many cases by use of the CR7 crystals, which are supplied with temperature coefficient as low as ±.0025% of frequency over a range of —55 to 90°C. Crystals with frequencies from 2.5 to 30 mc fundamental operation, and up to 150 mc on mode operation are available in a holder that measures but .75 x .34 x .75 in. The holder uses glass-to-metal seals to bring out .05 in. pins which will fit standard loctal sockets. Type CR-7 units will withstand continuous heat shocks of —70 to 100°C, and exceed Army-Navy specifications for vibration and drop resistance. — *Hunt Corp., 133 N. Hanover St Carlisle, Pa.*

THIS PROVES IT!



Cascade

PHASE SHIFT MODULATION

RAYTHEON FM

IS BETTER...

12 Ways

BECAUSE IT:

1. Features direct crystal control
2. Gives the most desirable electrical characteristics
3. Contains fewest circuits, fewest tubes
4. Has the simplest circuits
5. Is easiest to tune and maintain
6. Has *inherently* the lowest distortion level

AND ELIMINATES ALL:

7. High orders of multiplication
8. Complex circuits
9. Expensive special purpose tubes
10. Discriminator frequency control circuits
11. Pulse counting circuits for frequency control
12. Motor frequency stabilizing devices

RAYTHEON

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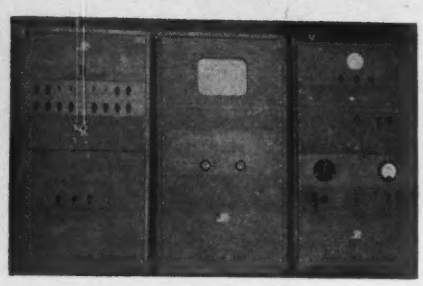
See your consulting engineer and write for fully illustrated booklet giving complete technical data and information. Write today to:

RAYTHEON MANUFACTURING COMPANY

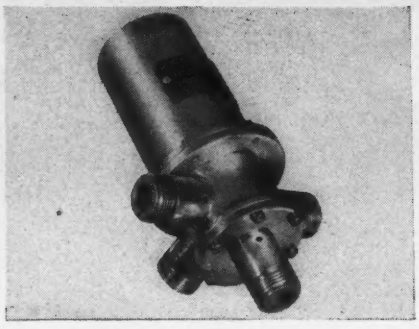
***Broadcast Equipment Division,* 7475 North Rogers Avenue, Chicago 26, Illinois**



TELEVISION STUDIO EQUIPMENT

(Use Inquiry Card, Mentioning No. 557)

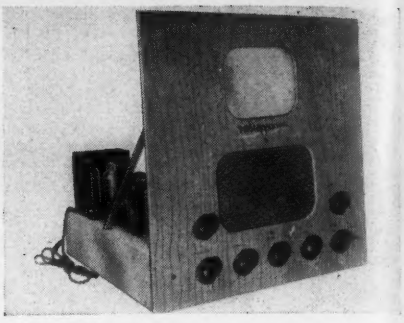
Television rehearsal studio equipment, developed for schools, department stores, etc., includes an iconoscope camera, two monitor viewer units (center), camera control and amplifier units (left), synch. pulse unit (right) and microphones and lamp banks. The camera uses the RCA 1848 Iconoscope. The camera control equipment consists of a video amplifier (top left), shading amplifier (centerleft), 14-watt audio amplifier and power supplies (bottomleft). The synchr. pulse rack contains a 3 in. CR pulse monitor (topright), synch. and blank pulse generator (below), switch and meter panel(center) and a triple regulated power supply (bottom). All equipment operates from the 115-volt, 60 cycle, ac line. — *Television Projects Inc., 24 Walnut St., Newark 2, N.J.*



RF COAXIAL SWITCH

(Use Inquiry Card, Mentioning No. 558)

Intended for antenna switching and remote control instrumentation this compact microwave switch is specifically designed to have a minimum reflection loss in the rf range up to 5,000 megacycles. The voltage standing wave ratio is almost flat from 500 to 4000 mc, being less than 1.2 at 3000 mc. Characteristic impedance of the switch is 50 ohms, insertion loss 3 db at 3000 mc, power rating 100 watts, voltage rating 500 volts peak, and cross talk 60 db. The unit is weatherproof and small in size and weight, making it suitable for airborne equipment applications. — *General Communications Co., Boston, Mass. Distrib. through Hastings Sales Engineering Co., 532 Commonwealth Ave., Boston 15, Mass.*

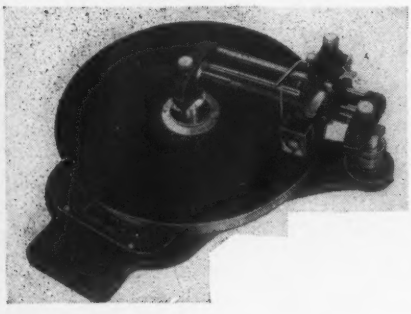


TELEVISION KIT

(Use Inquiry Card, Mentioning No. 559)

Designed to supply a high quality television receiver at considerably lower cost than a completed set, the Transvision television kit overcomes the problem of assembly by laymen through pre-tuning and pre-alignment of all critical rf assemblies, and by supplying a completely punched out chassis, along with detailed instructions. The 18-tube receiver uses a 7-in. Lectrovision picture tube for good visibility. Bandwidth in the video circuits is 3.5 mc. Signal sensitivity is 100 microvolts. The kit is pre-tuned for any three stations specified. No test equipment or tools besides soldering iron, screwdriver, and cutting pliers are needed. — *Transvision Inc., 385 North Ave., New Rochelle, N.Y.*

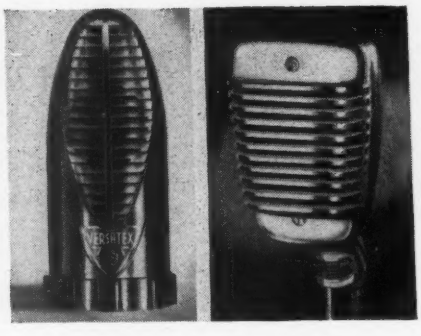
Sound and Recording Equipment



RECORDING TURNTABLE

(Use Inquiry Card, Mentioning No. 560)

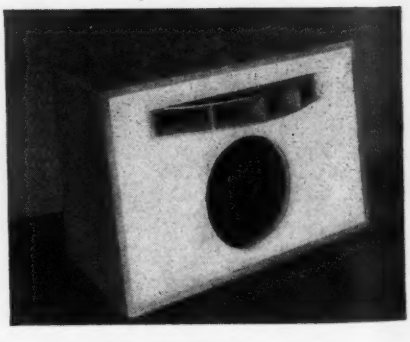
Model "V" 16 in. recording turntable, provided with a semi-automatic self locking speed shift for 78 and 33 1/3 rpm, is lathe turned, balanced and made of tested aluminum alloy casting. Illustration shows turntable with Rek-O-Kut model "M-5" recording mechanism mounted. The unit is provided with a continuous duty, capacitor type motor, having a dynamically balanced rotor. Chassis is of cast-iron, ribbed-L beam type, and designed to rest on three points, when mounted. Idlers are made of an oil and wear resisting neoprene compound. The turntable is available as "Deluxe" model with automatic speed shift or as "Standard" model without the special speed shift. — *Rek-O-Kut Co., 146 Grand St., New York 13.*



MICROPHONES

(Use Inquiry Card, Mentioning No. 561)

The model CX30 "Versatex" crystal microphone is a flexible unit for table top, hand, or floor stand supplied in a functional plastic case. It is efficient for recording, communications and low-cost PA systems. Output voltage of the semi-directional unit with 7 ft. cable is 53 db below 1 volt/dyne/cm². The same company has developed the "Sonodyne", a sensitive moving-coil dynamic microphone efficient in high temperature and high humidity locations. The semi- directional unit has a frequency response from 70 to 9,000 cps. Output level is 52 db below 1 volt/dyne/cm². — *Shure Brothers, Inc., 225 W. Huron St., Chicago 10, Ill.*



HIGH FIDELITY SPEAKER

(Use Inquiry Card, Mentioning No. 562)

Having a distribution angle of 90° and a frequency response uniform from 60 to 15,000 cps, type 757A dual loudspeaker, consisting of the 728B unit as low frequency speaker and the 713C receiver as high frequency reproducer, is designed for FM and AM broadcasting, recording studios and other high fidelity applications. A four-step attenuator and the 702-A network is used for dividing the audio frequency range to feed the two speakers. Power handling capacity of the unit is 25 watts, input impedance being 4 ohms. It is furnished in an acoustically treated utility cabinet.— *Western Electric Co., Inc., 195 Broadway, New York 7.*

Keep the sparkle in your programs...

with the New Collins 20T 1 kw AM transmitter

Let the brilliant overtones of high fidelity flow through circuits engineered *for* high fidelity. The 20T development, a new post-war success, reveals in each detail the quality of its design.

Dual oscillators. Two temperature-controlled oscillators, adjusted to your operating frequency, are self-contained in the 20T. A selector switch enables you to place the spare unit in operation when you remove the other for maintenance.

Two cabinets. Past practice has been to crowd a kilowatt transmitter into a single cabinet. The Collins 20T gives you two cabinets with lots of room, genuine accessibility, ample ventilation, and impressive appearance.

Program protection *and* circuit protection. In addition to magnetic circuit breakers and two-shot d-c overload relays, the 20T has high voltage capacitor fusing. Should a capacitor fail, the fuse opens the circuit and a spring bar shorts the capacitor terminals. The transmitter stays on the air and the faulty capacitor is indicated.

Filament voltage regulator. For longer tube life, and low noise and distortion levels, the 20T tube filaments have a constant voltage supply.

Attractive styling. The cabinets are attractively styled in three-tone gray. Their modern, distinctive appearance, simplicity of design, and pleasing color harmony will give many years of eye appeal and satisfaction.

Eye level metering—centralized controls—motor driven tuning elements—forced air cooling—high safety factors—30-10,000 cps audio response ± 1.0 db—3% audio distortion—minus 65 db noise level.

Only the Collins 20T gives you all these desirable and important features. Deliveries will begin early this year. We suggest you write for detailed specifications, study them, compare them, and then place your order for early delivery. Let us supply your entire equipment needs. You'll have an integrated system that will keep the sparkle in your programs and put a sparkle in your station.

FOR BROADCAST QUALITY, IT'S . . .

COLLINS

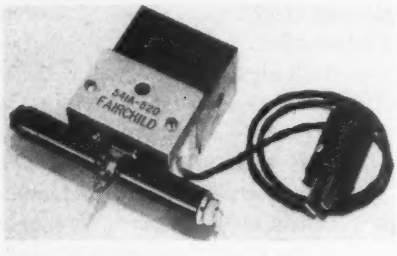
COLLINS RADIO COMPANY, Cedar Rapids, Iowa

11 W. 42nd St., New York 18, N. Y. **458 S. Spring St., Los Angeles 13, Calif.**

LIMITING AMPLIFIER

(Use Inquiry Card, Mentioning No. 563)

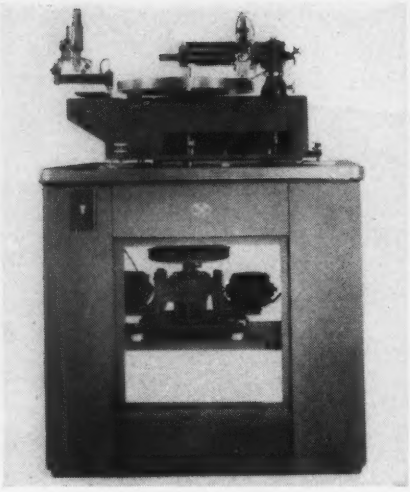
The Langevin type 119-A Progar differs from the usual limiting amplifier in that it is a fast acting peak limiter preceded by an automatic gain control amplifier with variable time constants. In broadcast station application the action of this combination of amplifiers results in a higher precentage modulation than can be obtained with a limiter alone. If the program level increases the peak limiter section is designed to maintain the original level while introducing no appreciable waveform distortion. The "Guardian" section of the Progar reduces its gain to meet the new level, thus permitting the limiter to restore to normal. If the average program level decreases, the Guardian automatic gain control registers the decrease and takes corrective action after a pre-determined adjustable time delay. The unit has a normal gain of 55 db and a frequency response flat within ±1 db from 30 to 15,000 cycles. The Guardian section has a control range of 35 db, the limiter section 20 db with a compression ratio of 10:1. Input and source impedance are 600 ohms. Consumes 150 watts at 150-125 volts, 60 cycle, ac. — *The Langevin Co., 37 W. 65th St., New York* 23.



MAGNETIC CUTTERHEAD

(Use Inquiry Card, Mentioning No. 564)

To meet requirements of both AM and FM broadcasting and professional recording, the Fairchild magnetic cutterhead type 541A guarantees a frequency response of ±2 db over the 30 to 8,000 cycle range at a high recording level. The unit is supplied with standard mounting plate for any current model sound recorder. Impedance of the head is 500 ohms and 0.6 watt driving power is required. A ⅝ in. long, .062 in. diam. stylus can be accommodated. — *Fairchild Camera and Instrument Corp., Jamaica, N. Y.*



PROFESSIONAL RECORDER

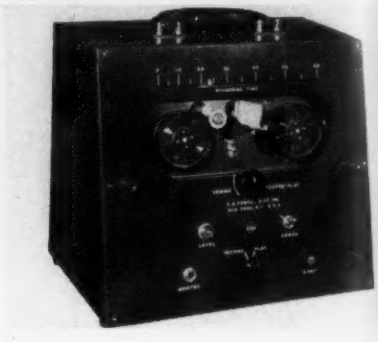
(Use Inquiry Card, Mentioning No. 565)

The Presto 8D-G recorder is directly gear driven at both 33 1/3 and 78.26 rpm. Separate 1800 rpm synchronous motors are used for each speed, selection being made by actuating a special double-throw mercury switch. Mechanical filters isolate drive mechanism from turntable. Inside-out and outside-in cutting pitches are provided for 88. 96, 102, 120, 128 and 136 lines. Mechanical noise level is better than -50 db below program level. The recorder is equipped with Presto 1-D cutting head. Also available is model 8D, which is of the rim-drive type, but otherwise identical with model 8D-G —*Presto Recording Corp., 242 W. 55 St., New York* 19.

PORTABLE RECORDER

(Use Inquiry Card, Mentioning No. 565)

A complete portable recording unit of professional quality combines in a single case the recorder, playback pickup, amplifier, and speaker, with provisions for installing a radio tuner. Model RA-116 accommodates acetate recording discs from 6 to 16 in., as well as 17 1/2 in. masters. Turntable speeds of 33 1/3 and 78 rpm are held to within .5% The unit cuts "inside-out" or "outside-in" and has variable pitch adjustment from 96 to 120 lines per in. The four-stage amplifier has two high impedance input channels, each having two jacks, with individual volume controls. Treble and bass are separately controlled, +15 db to −20 db in the low range, and ±15db in the upper range. Frequency response of amplifier is within ±1 1/2 db from 35 to 15,000 cps, distortion being less than 1% at cutting level. Rated output is 10 watts to load impedance of 8 ohms. The instrument operates at 110-120 volts, 50-60 cycles, ac and consumes 150 watts. — *Ellinwood Industries, 150 W. Slauson Ave., Los Angeles* 3, *Calif.*



WIRE RECORDER

(Use Inquiry Card, Mentioning No. 567)

Designed for commercial use by recording studios, radio stations, schools, etc., the model B sound-on-wire recorder can be used in conjunction with a suitable amplifying system to provide one hour of continuous recording on 7,500 ft. of a fine, stainless-steel wire. Recording may be edited by cutting unwanted wire. Frequency response of the unit is flat within ±5 db from 80 to 5000 cycles. A 1-hour recording may be rewound in 8 minutes. Mechanical features include a capstan drive to keep wire speed constant, magnetic clutches for constant wire tension, and safety switches which stop the motor before spool is unwound. The recorder operates on 110 volt, 60 cycle, ac. — *Produced by WiRecorder Corp., Detroit. Available from R. C. Powell Co., Inc., 57 Williams St., New York* 5.

OUTPUT ATTENUATORS

(Use Inquiry Card, Mentioning No. 568)

Providing distortionless control of amplifier output or individual loudspeaker input in multi-speaker layouts, the Clarostat constant-impedance output attenuators are capable of handling up to 10 watts power output. Attenuation range is linear up to 30 db. CIB attenuators have absolute zero insertion loss.—*Clarostat Mfg. Co., Inc., 130 Clinton St., Brooklyn, N. Y.*

SPRAGUE

VITAMIN Q DIELECTRIC

(TRADEMARK REG. U. S. PAT. OFF.)

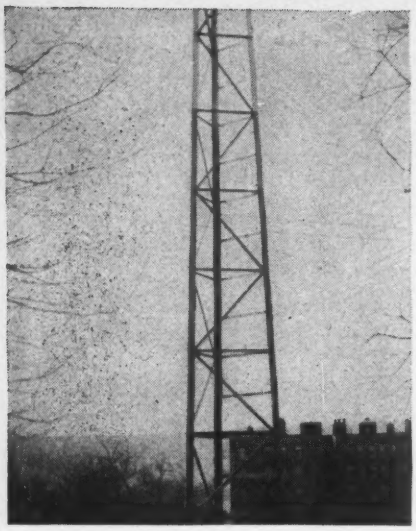
HAS PERMITTED SUBSTANTIAL REDUCTIONS IN BOTH THE SIZE AND WEIGHT OF MANY OIL-FILLED CAPACITOR TYPES

TYPICAL! Compact Capacitors for Photoflash and Energy Storage Uses

Sprague Capacitors with Vitamin Q dielectric have led in establishing new standards of compactness, light weight and dependability for electric flash tube (photoflash) photography. Also, they assure outstanding economies and greater efficiency for flash welding and time control circuits where duty cycles other than those used in photoflash work prevail. Write for Sprague Engineering Data Bulletin No. 3205.

SPRAGUE ELECTRIC COMPANY, North Adams, Mass.

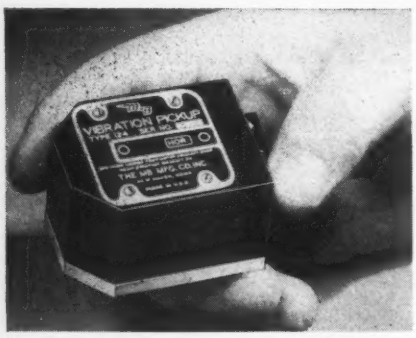
PIONEERS OF ELECTRIC AND ELECTRONIC PROGRESS



ALUMINUM ANTENNA TOWERS

(Use Inquiry Card, Mentioning No. 569)

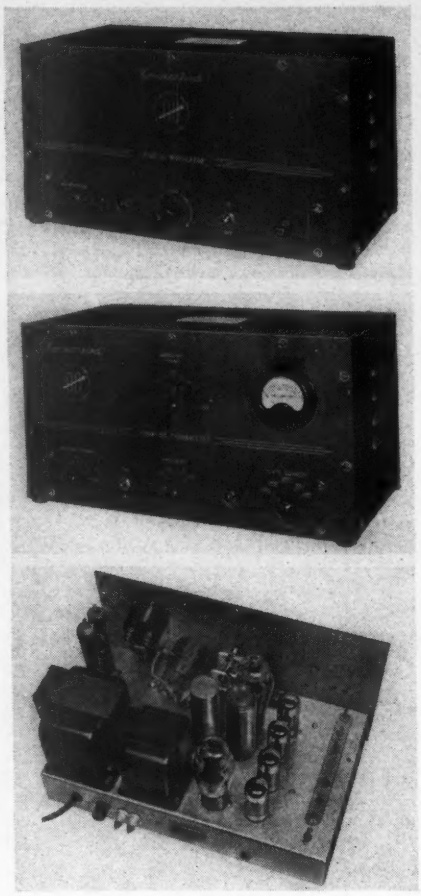
Specifically designed for directional beam antenna operation by amateur radio operators or for commercial applications, these low-cost aluminum antenna towers can be assembled by one man and erected by three, without aid of mechanical gear. The lightweight, self-supporting units can be furnished 30 ft., 20 ft., or 10 ft. long, in ten-foot sections, weighing 160 lbs. The towers are guaranteed to support 200 lbs. with a projected area of 5 sq.ft. of flat surface in a 70 mile wind. Allowable top load in still air is 600 lbs. Approx. one cubic yard of concrete is required for ground installation of the 30 ft. tower.—*Fabricated Lightmetals Co., 42 W. 15 St., New York 11.*



VIBRATION PICKUP

(Use Inquiry Card, Mentioning No. 570)

MB vibration pickup, type 124 is a sensitive, rugged instrument which generates a voltage proportional to the velocity of the vibrational component perpendicular to its base. Useful for a frequency range from 5 to 1000 cps, the pickup generates a voltage by the motion of a small coil, mounted on the end of a pivoted shaft, and free to move in a magnetic field created by two Alnico magnets. Sensitivity of the instrument is 21 mv per .001 in. double amplitude per 100 cps.—*The MB Mfg. Co., New Haven, Conn.*



AMATEUR TRANSMITTER

(Use Inquiry Card, Mentioning No. 571)

Covering all amateur frequencies between 3.5 and 28 mc, model Four-20 transmitter features Mono-Sequence tuning, a patented Hammarlund development which makes possible the tuning of four different, but harmonically related frequencies, by one control. The four-20 transmitter has a 7C5 crystal oscillator, three 7C5 multipliers, an 807 final amplifier. Power output is 20 watts. Tuning of the oscillator stage and three multiplier stages is accomplished by a single control. The meter switching arrangement provides visual indication of the performance of each stage. The unit includes a built-in keying relay and key click filter. The companion unit, the Four-11 modulator incorporates push-pull 7C5's in its final stage, and has sufficient power to modulate the transmitter.—*Hammarlund Mfg. Co., 460 West 34th Street, New York.*

RF EXCITER UNIT

(Use Inquiry Card, Mentioning No. 572)

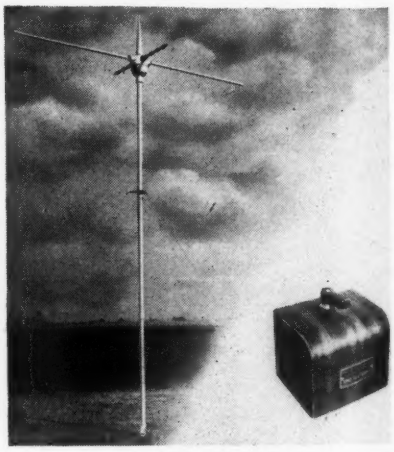
The Collins 310B exciter unit, rated at 15 watts output on all amateur bands under 32mc, incorporates the permeability - tuned 70E-8 VFO, which has an accurate direct-reading frequency dial. The 6SJ7 oscillator is followed by three 6AG7 multipliers and a 2E26 rf amplifier. Multipliers are gang-tuned and use band-switching. Keying is accomplished in the cathode of the first 6AG7. The

310B has separate multiplier and amplifier tuning controls, a function switch (M.O.Test - Standby - Send), bandswitch, meterswitch, and power switch. Output is sufficient to drive a 1 kw final amplifier.—*Collins Radio Co., Cedar Rapids, Iowa.*

SYNTHETIC DAMPING MATERIAL

(Use Inquiry Card, Mentioning No. 573)

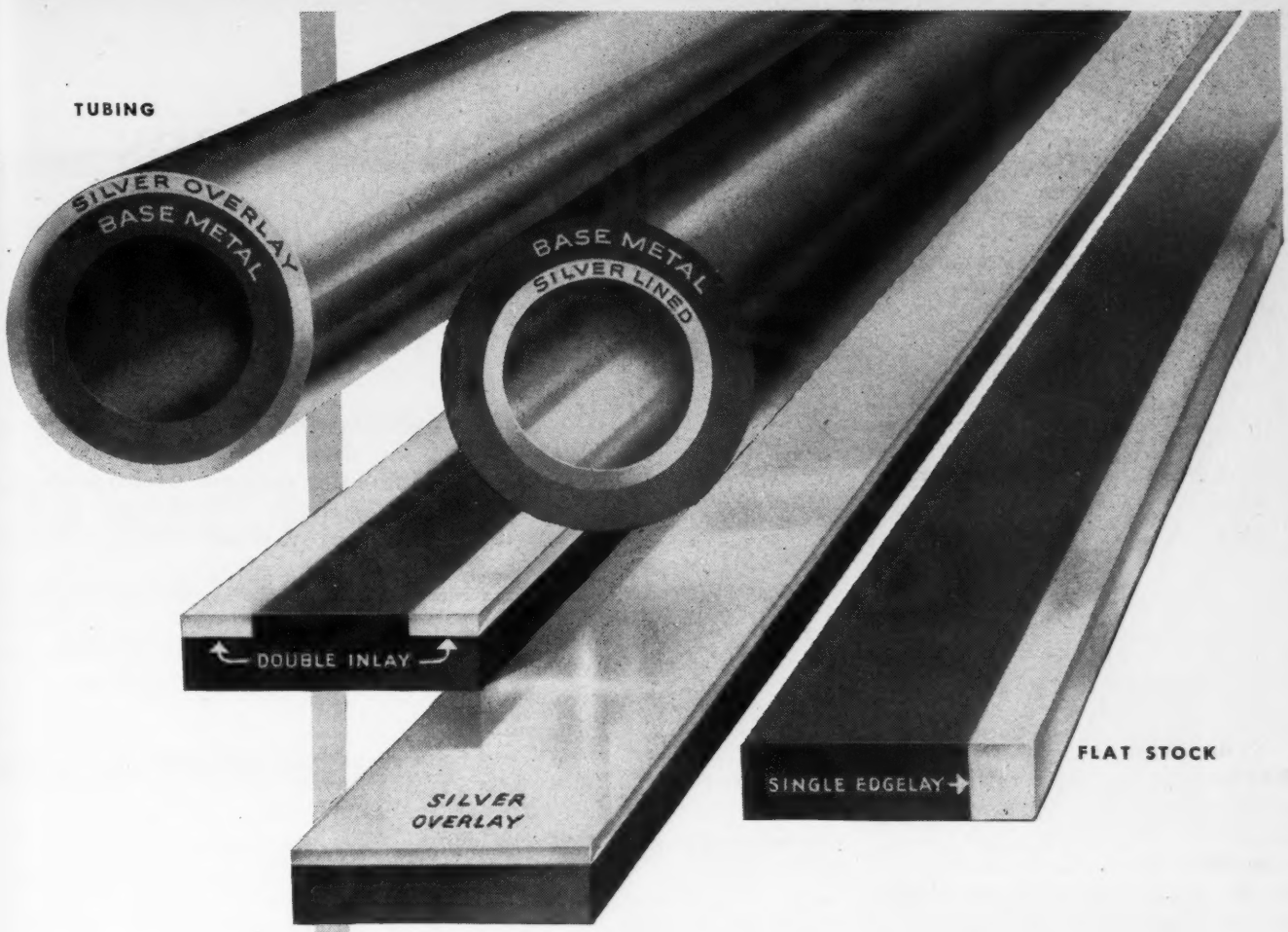
Audioid "A" is a long-life, viscous synthetic designed to restrain and make uniform the mechanical frequency response of electro-acoustic devices such as cutting heads, pick-ups, microphones, etc. The material will not loosen at the clamping points, but tends to adhere to the surface of the clamping members. Non-linear and temperature effects are minimized. "Audioid" is easily cut and shaped; it is available in ⅛ and 1/16 in. sheets for laminating to desired thickness.—*Cook Laboratories, 139 Gordon Blvd., Floral Park, N. Y.*



ROTATABLE TV ANTENNA

(Use Inquiry Card, Mentioning No. 574)

This rotating double dipole covers all television bands by means of arms set at different mean frequencies. By throwing a remote control, DPDT switch located at the receiver, the head can be rotated clockwise or counterclockwise in a complete 360° circle to adjust the antenna broadside to the station. The antenna is operated by a 24-volt motor controlled by a spring-loaded switch in the control box. It helps eliminate ghosts, roof-top antenna shifting, and improves weak reception.—*Kings Electronics, 372 Classon Ave., Bkl'n. 5, N.Y.*



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Give You Silver ONLY Where You Need It

A thin layer of silver, or other precious metal, permanently bonded to a heavier, inexpensive base metal... that's General Plate Laminated Metals. It means that you get all the advantages of precious metals yet costs are much less . . . especially important today with the high cost of silver.

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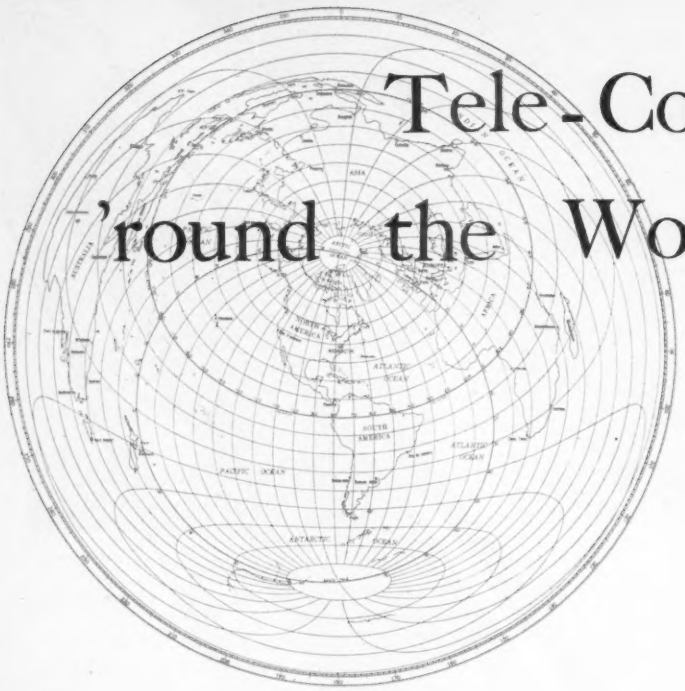
ATTLEBORO, MASSACHUSETTS



Tele-Communications 'round the World

By ROLAND B. DAVIES,
Tele-Tech Washington Bureau

News of engineering matters of importance and of markets in various foreign fields

EVALUATING WORLD MARKETS—Now that the severe winter conditions are over and the toll of hardships and damage has been eradicated, the economic conditions in the war-ravaged continents of Europe and Asia can be evaluated more accurately from the standpoint of future exports of U. S. radio apparatus and components. There is no question but that the competition from the manufacturing plants of the nationals in the respective countries is greater than ever before and that American manufacturers will have a stiff battle in foreign markets.

But the coming World Radio Conference at Atlantic City which is to be attended by around 600 foreign delegates—the cream of the radio experts of the globe—will stimulate great interest from overseas in American radio-electronic developments and progress.

The plans for use of mobile radiotelephone, radar, railroad radio, aviation radiocommounications and navigation aids, which have been blueprinted in the United States and are being put into being, have greatly aroused the interest of the foreign governments and leading foreign radio manufacturers and laboratories' chieftains. This may be a most fertile field for export sales of U. S. equipment.

For broadcasting export sales, South America is definitely the most promising market. The column carried a summary of the prospects in Latin America in the April TELE-TECH. After its publication it is interesting to note that the Wall Street Journal of April 3 carried a similar article, giving the figures of the receiver set export sale prospects for each respective Latin American nation.

ARGENTINA GOOD POTENTIAL MARKET FOR FM—Though only two FM stations now are operating in Argentina, that country is believed to present excellent market possibilities for U. S. receivers. Government interest in FM is said to be considerable and it has been indicated that a number of receivers may be imported from the U. S. for military use while at the same time the public is being canvassed for views on that form of broadcasting. Reports indicate the U. S. is in a most favorable position to supply any future Argentine demand for FM sets. It is believed these could be imported assembled but that the high exchange rate in the country would favor assembling in Argentina. General Electric Co. of Argentina operates one of the FM stations on an experimental basis while the other is operated by government.

INDIAN GOVERNMENT TO EXPAND BROADCASTING—An 8-year plan, which should form the first stage of development of broadcasting in India and is projected to cost 35,700,000 rupees non-recurring and 8,600,000 rs. annually, has been approved by the Government of India Development Board.

The main features of the plan are: The installation of eight high-power medium-wave transmitters in urban areas; five zones of India to be considered on the basis of linguistic, musical and similar cultural affinities; and new transmitters will be installed as and when necessary equipment and staff become available.

There is no project for television and private companies will not be allowed to set up broadcasting stations, the Indian government reported. In addition, commercial advertising will not be permitted over the broadcasting facilities.

CANADA TO GO AHEAD WITH FM—Though development of FM in Canada is definitely in its infancy, plans for furthering that form of broadcasting call for construction of a number of new stations this year and power increases of those in operation to 6000 watts in the near future despite the fact that no indications have been given of any considerable listener interest in the medium.

The Canadian Broadcasting Corp. has taken the attitude, it is reported that it will carry out a program of station construction, believing that interest in FM will then increase to the point that sufficient receivers

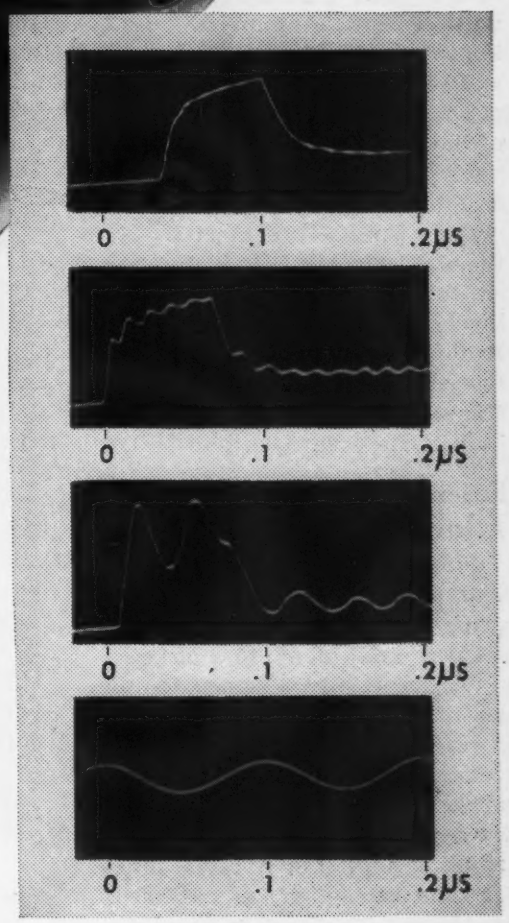
(*Continued on page* 111)

1550 MILES A SECOND!!

That's the writing rate recordable with

DU MONT'S Type 5RP CATHODE-RAY TUBE

operating at 25,000 volts accelerating potential!



Typical high-speed single-transient recordings with 5RP at 18,000 volts accelerating potential. (Courtesy of Prof. M. Newman, Institute of Technology, University of Minnesota.)

The speed at which this Du Mont tube clearly writes with adequate brilliance is indicative of the trend in modern oscillography toward high accelerating potentials without loss of deflection sensitivity. A total of 25,000 volts accelerating potential is applied by dividing that potential across multiband intensifiers.

As exemplified by the Type 5RP, adequate brilliance is obtained from signals which cannot be seen on an ordinary cathode-ray tube, *without serious loss of deflection sensitivity and practically no distortion with Eb3/Eb2 ratios as high as 10!* For high-frequency signals, the Du Mont 5RP is especially useful because of its low-capacitance deflection system.

Write for descriptive literature.

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DUMONT *Precision Electronics & Television*

ALLEN B. DUMONT LABORATORIES, INC., PASSAIC, NEW JERSEY • CABLE ADDRESS: ALBEEDU, PASSAIC, N. J., U. S. A.

News of the Industry

See Parts Show Record

Advance registration for the radio parts show, to be held at the Hotel Stevens, Chicago, during the week May 13-16, points to the most successful show of this type ever to be held. The total advance registration is 2054, with 855 member-exhibitors, 39 guest exhibitors, 489 NEDA members, 274 non-NEDA distributors; and 367 representatives included in this figure.

Principal speaker for the Keynote Dinner, to be held on May 12, will be Bill Cunningham, well-known syndicated sports writer and radio commentator. Jack Berman, of Sure Brothers, president of the show corporation has designated Monday, May 11 NEDA Day. Events during that day will include a special breakfast by National Electronic Distributors Assn. for member exhibitors; and a luncheon meeting for members of Radio Manufacturers Association, Electronics Parts and Equipment Manufacturers, Sales Managers Club Eastern Division and NEDA.

Emerson Enters Industrial Television Production

Entering the industrial television field, Emerson Radio and Phonograph Corp., New York, has developed and plans to market a system especially designed for the use of industrial and educational institutions. The equipment includes the customary camera and microphone unit, a combined viewer and speaker, a central distributing unit and a radio tuner for the reception of standard broadcasts. The equipment is designed to view various industrial operations and to make those operations visible to one or more executives remote from the manufacturing processes.

PICAO Becomes ICAO

Early last month the Provisional International Civil Aviation Organization, which came to be known as PICAO, dropped the first letter of its designation and officially became International Civil Aviation Organization. In the future all activities of the Organization PICAO will carry on as ICAO. The first meeting to be held on May 6 in Montreal.

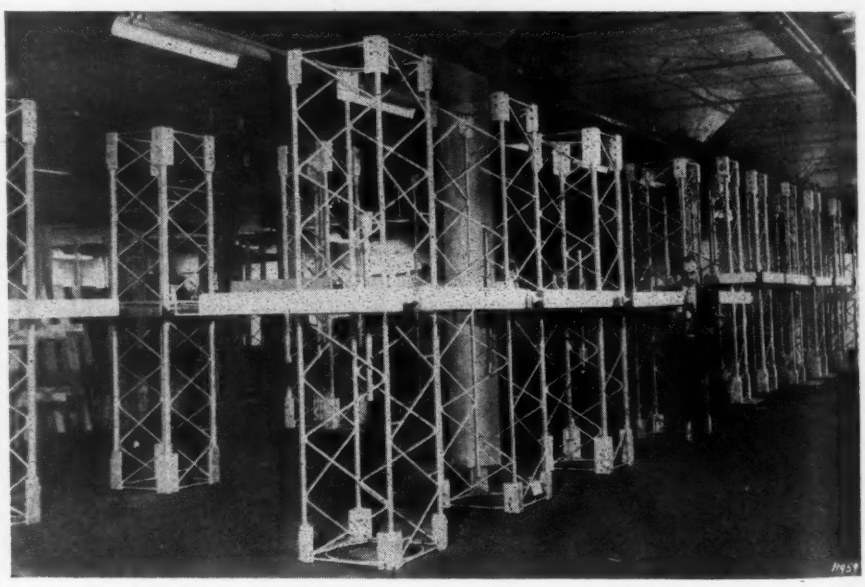
Webster To FCC

Bringing membership of FCC up to its full strength of seven members for the first time since the resignation of former Chairman Paul Porter, President Truman has nominated Commodore Edward M. Webster to the existing vacancy on the Commission. He had formerly served as assistant chief engineer, latterly has been director of telecommunications of the National Federation of American Shipping.

GE's Minature FM

By way of increasing the use of FM broadcasting by educational institutions, General Electric Co., Syracuse, is to produce tiny low-powered FM broadcasting transmitters which will be extremely economical to own and to operate. The GE FM plan calls for the use of transmitters having a power output of only two and a half watts. It is estimated that such equipment, which eventually could be enlarged to a full-sized educational FM station with up to 50 kw power, would have a five or six mile range which is considered sufficient to cover most college campuses, fraternity and sorority houses, etc.

ANTENNA FOREST—Federal's square loop FM antennas undergoing final inspection



CONVENTIONS AND MEETINGS AHEAD

May 3—Cincinnati Section of the Institute of Radio Engineers—Technical conference featuring television, Cincinnati, Ohio. E. J. Bussard, Crosley Corp., 1729 Arlington, Cincinnati.

May 4-8—National Electrical Wholesalers Assn.—38th Annual Convention, Hotel Traymore, Atlantic City, N. J.

May 5-7—International Scientific Radio Union (American Section) and Institute of Radio Engineers—Joint meeting, Washington, D. C.

May 6-10—Society of the Plastics Industry—Annual Convention (Stevens Hotel) and National Plastics Exposition (Coliseum), Chicago.

May 13-16—Radio Parts and Electronic Equipment Conference and Show—Stevens Hotel, Chicago.

May 15—World Telecommunications Conference—Ambassador Hotel, Atlantic City, N. J.

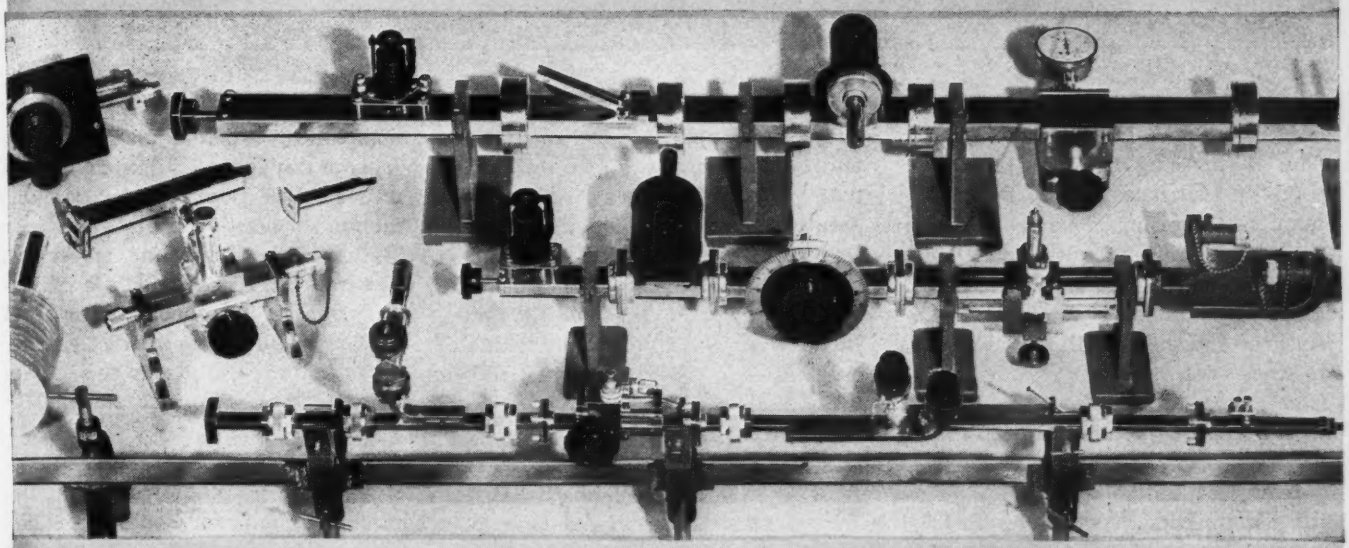
May 17—Institute of Radio Engineers, North Atlantic Region—Radio engineering meeting, Hotel Continental, Cambridge, Mass. John M. Clayton, General Radio Co., Cambridge.

June 7—Institute of Radio Engineers—Annual Conn. Valley Section meeting, New London. Half-day session on FM receivers.

June 16-20—American Society for Testing Materials—Annual (15th) Meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

DE MORNAY BUDD STANDARD TEST EQUIPMENT

For Precision Measurements in the Microwave Field



The complete line of De Mornay·Budd standard test equipment covers the frequency range from 4,000 mcs. to 27,000 mcs. It provides all R. F. waveguide units necessary for delicate, precision test work requiring extremely high accuracy in attenuation measurements, impedance measurements, impedance matching, calibration of directional couplers, VSWR frequency measurements, etc.

To eliminate guesswork, each item of this De Mornay·Budd test equipment is individually tested and, where necessary, calibrated, and each piece is tagged with its electrical characteristics. All test equipment is supplied with inner and outer surfaces gold plated unless otherwise specified.

NOTE: Write for complete catalog of De Mornay·Budd Standard Components and Standard Bench Test Equipment. Be sure to have a copy in your reference files. Write for it today.

The three test set-ups illustrated above include:

- Tube Mount
- Flap Attenuator
- Frequency Meter
- Calibrated Attenuator
- Tee
- Stub Tuner
- Tunable Dummy Load
- Standing Wave Detector
- Type "N" Standing Wave Detector
- Directional Coupler
- Hight Power Dummy Load
- Cut-Off Attenuator

Stands, etc.

DE MORNAY BUDD

EQUIPMENT FOR 97% OF ALL RADAR SETS

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WASHINGTON

★ ★ ★ **Latest Electronic News Developments Summarized by Tele-Tech's Washington Bureau** ★ ★ ★

GOOD SIGN FOR INDUSTRY—The engineering triumvirate in the topflight functioning of the FCC augurs promising results for the radio-electronic manufacturing industry in the Commission's engineering standards for new radio services and the growth and progress in Television and FM broadcasting. Commodore E. M. Webster, Coast Guard chief of communications and prewar FCC Assistant Chief Engineer, was inducted April 10 into the Commission, completing FCC's complement of seven Commissioners for the first time in two years.

ENGINEERING TO THE FORE—The combination of Commodore Webster, who has the highest type of reputation in the radiocommunications and mobile radio-radar fields, with present Commissioner E. K. Jett, another exceptionally regarded Commissioner, and the new FCC Chief Engineer George Sterling, means the FCC will move ahead much more efficiently and constructively in its consideration of technical problems and subjects. Instead of too much emphasis, as in the past, being given to the legal viewpoint with regard to engineering issues of the radio-electromic industry, especially those matters affecting development of new devices and their operation in their allotted places in the radio spectrum, TELE-TECH's Washington bureau feels that under this new leadership the Commission will delve into such spheres as it affects manufacturers with dominant stress on the technical and engineering facts.

HEADACHES IN PATH OF PROGRESS — Television with the impetus by the FCC to continue black-and-white video and color high-definition television to be the subject of further experimentation and field testing was moving ahead with manufacturers projecting greatly increased production of receivers with estimates of 400,000 sets on the market this year, more than quadrupling 1946 output. But one "headache" is developing in video's progress — the inter-city relay method. The AT&T coaxial cable system is being constructed but for this year the best television network possibility is along the North Atlantic seaboard between the present New York-Philadelphia-Washington link which is to be extended to Boston and Schenectady.

FM INTERFERENCE PROBLEMS—FM broadcasting has been having its troubles both in cross-talk interference between too closely adjacent stations and in disrupting aviation instrument landing systems. But the FCC has worked out a pattern of reallocation of FM channels with increased channel separation of 800 kc for same-city stations in most areas and three channel separation in some sections. However, this problem has stimulated the efforts of the FM broadcasters for greater assignment of spectrum space above the present 80 commercial FM channels. The aviation ILS problem is being remedied by reassignment of FM stations in areas adjacent to major airports.

MOBLE RADIOTELEPHONE SERVICES MUSHROOMING — With tremendous growth in mobile radiotelephone services, the FCC soon will have to consider twofold problem — the allocation of more frequency space and the division of the services into specialized categories. The taxicab industry already has well over 10,000 units, operated by around 1500 different taxicab companies, which amounts to millions of dollars in equipment expenditures. Now comes a new potential mobile service — the State Highway Maintenance Departments — which pictured to TELE-TECH's Washington bureau prospects of around 100,000 mobile units in the next few years if the FCC places the service on a full public service status.

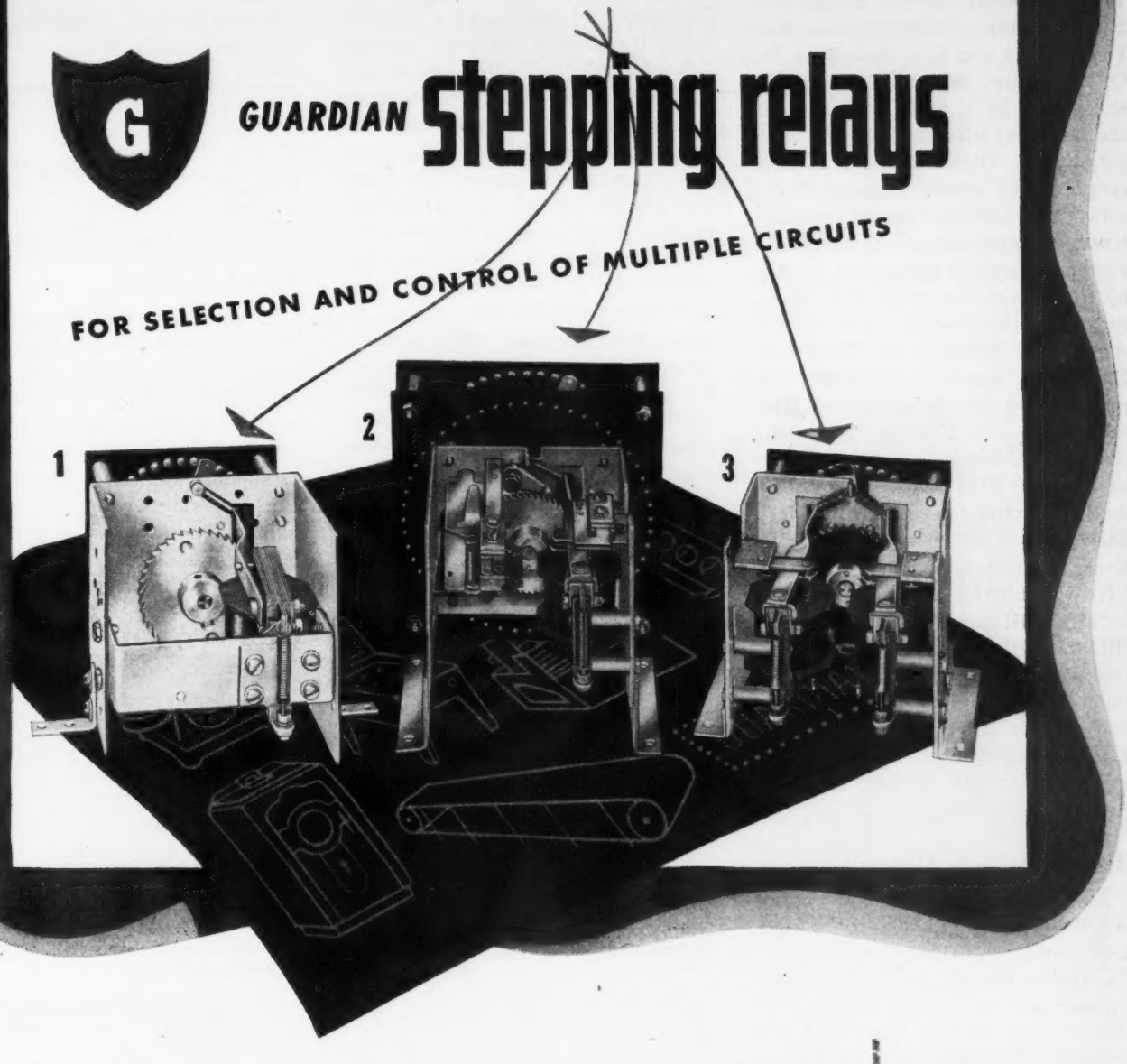
OIL INTERESTS PLAN EXPANSION—The petroleum industry also has huge plans for radio expansion both in mobile services in the oil fields and for pipe lines and in radio-electronic devices for geophysical exploration. Like the taxicab and state and country highway departments, it wants to be placed in a separate service classification with separate rules and engineering standards. All these new radio services are seeking a longer license period of three or five years instead of the present one-year experimental license. It all adds up to booming prospects for the manufacture of the equipment in this field.

AVIATION WANTS "SYSTEM" — Major General McClelland in an interview with TELE-TECH's Washington bureau feels that the controversy over electronic aids to avigation can be spelled out through joint government-airlines-manufacturing industry research and testing to achieve a complete system rather than pieces of equipment. In other words, he feels there should not be a quarrel between GCA and ILS but a coordination of the two. RCA's "Teleran" was demonstrated recently before the Senate and House Committees studying aviation navigation aids and elicited the highest praise from Congress.

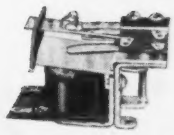
ROLAND C. DAVIES
Washington Editor

GUARDIAN stepping relays

FOR SELECTION AND CONTROL OF MULTIPLE CIRCUITS

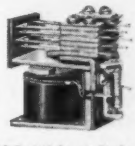


This trio of *standard* Guardian Stepping Relays: (1) continuous rotation, (2) electrical reset, (3) add and subtract—will start you off with a minimum of design and keep your product operating indefinitely. The Guardian Steppers shown are adaptable to numerous applications: automatic circuit selection; automatic sequence selection of circuits; automatic sequence cross-connection of circuits. They are used in automatic business machines, production totalizers, conveyor controls, animated displays, telephony, remote tuning, with a host of additional uses you will soon discover. On each, the contact finger rotates counter-clockwise. All three Steppers follow 10 pulses per second within the rated voltage range of the relay. Special construction prohibits skipping or improper indexing of the ratchet. Available in separate units or in combination with relays, contact switches, solenoids; completely assembled and wired to terminals; mounted on special bases or in enclosures. "Special" modifications are obtainable in production quantities. Write for Bulletin SR.



Series 100 Snap-Action Relay

Guardian Featherub Switch



Series 500 Midget Relay

Series 1-A Solenoid

GUARDIAN ELECTRIC

1622-F W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY

National Electronics Conference Picks Swinyard

The National Electronics Conference, Inc., which will stage its 1947 gathering at the Edgewater Beach Hotel in Chicago, on November 3, 4 and 5, is headed by W. O. Swinyard, Hazeltine Electronics, Inc., who is to be chairman of the board of directors for the current year. Other officers of the corporation, whose purpose is to serve as a national forum on electronic developments and their applications and is sponsored jointly by the Illinois Institute of Technology, Northwestern University, American Institute of Electrical Engineers, Institute of Radio engineers and the University of Illinois, with the Chicago Technical Societies Council cooperating are as follows: President, A. B. Bronwell, Northwestern University; Executive Vice-President, W. L. Everitt, University of Illinois; Vice-Presidents, G. H. Fett, University of Illinois; E. O. Neubauer, Illinois Bell Telephone Co.; H. S. Renne, Radio-Electronic Engineering; T. J. Higgins, Illinois Institute of Technology; Secretary, R. E. Beam, Northwestern University; Treasurer, E. H. Schulz, Armour Research Foundation.

Radar Officers Organize

Former Navy and Marine officers representing a group of approximately 2,000 who worked out the application of Radar in air and surface navigation and traffic control during World War II have formed a national Association of Electronic Reserve Officers to continue the association of experienced ex-officers in the application of electronic developments in aviation and navigation to national defense and civilian transportation safety. Included in the group are officers from all sections of the country who were active in the introduction and wartime use of radar and allied equipment and the initiation of procedures to detect and control aircraft and ship movements.

Lescarboura Honored

Austin C. Lescarboura, advertising consultant and one of radio's old-timers, who makes his headquarters in Croton-on-Hudson, N. Y., has been awarded the coveted order of "Officier de l'Instruction Publique", according to word received from the French Embassy. Lescarboura already holds the French order of "Officier l'Academie" and the decoration of the Academic Palms awarded for services to France and the Allies in World War I. The latest decoration is a promotion from the purple ribbon to the purple rosette. This honor, rarely awarded to an American, is highly regarded abroad as a recognition of outstanding achievement in the liberal arts. In past years Lescarboura contributed frequently to French technical and industrial publications, covering American progress particularly in radio-electronics. More recently he has been aiding visiting members of the French Mission for Industrial Production, particularly in their quest for radio, electronic and electrical information and guidance to speed up the rehabilitation of devastated French industry.

Plan 2,600,000 AM-FM Combinations for 1947

Production of 2,600,000 home receivers with FM facilities is forecast for 1947 by RMA. The figure is based on a survey designed to get a "realistic" report on the outlook for FM. Most of the 2,600,000 sets will be combination AM-FM units. Only 146,000 straight FM sets are planned. Following are the figures.

AM-FM Table Models	Number
Under $50	43,000
Over $50	810,000
Console Models	
With phonograph	1,595,729
Without phonograph	70,000
FM alone	146,000
FM Transmitter	
250 watts	90
1 kilowatt	230
3 kilowatts	205
10 kilowatts	185

Fast Tele Film

Eastman Kodak Research Laboratories technicians have developed a new type of motion picture film which will cut to a fraction of normal the time required to shoot news pictures and get them to the television audience. Eastman and Philco demonstrated the film last month. The film and a new developing process cuts developing time from 40 minutes to 45 seconds.

Lord in Providence

Lord Manufacturing Co., pioneers in the production of shock mounts, has established a field office in Providence, R. I. The address is Industrial Trust Building and the office will be in charge of Dan Rowan. The main office of the company is in Erie, Pa.

Typical installation of an RCA Teleran receiver in the cockpit of a flight simulator. Equipment gives the pilot all needed route, traffic and weather information on a single image screen on instrument panel

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The chart shows the typical demagnetization and energy product curves on which our engineers base their calculations. It shows the characteristics of various kinds of permanent magnet materials which can be expected in our production, and from which the optimum designs can be determined. Such fundamental information permits us to engineer the inside of your magnet so that each one will give you a maximum result.

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Watch for Indalloy

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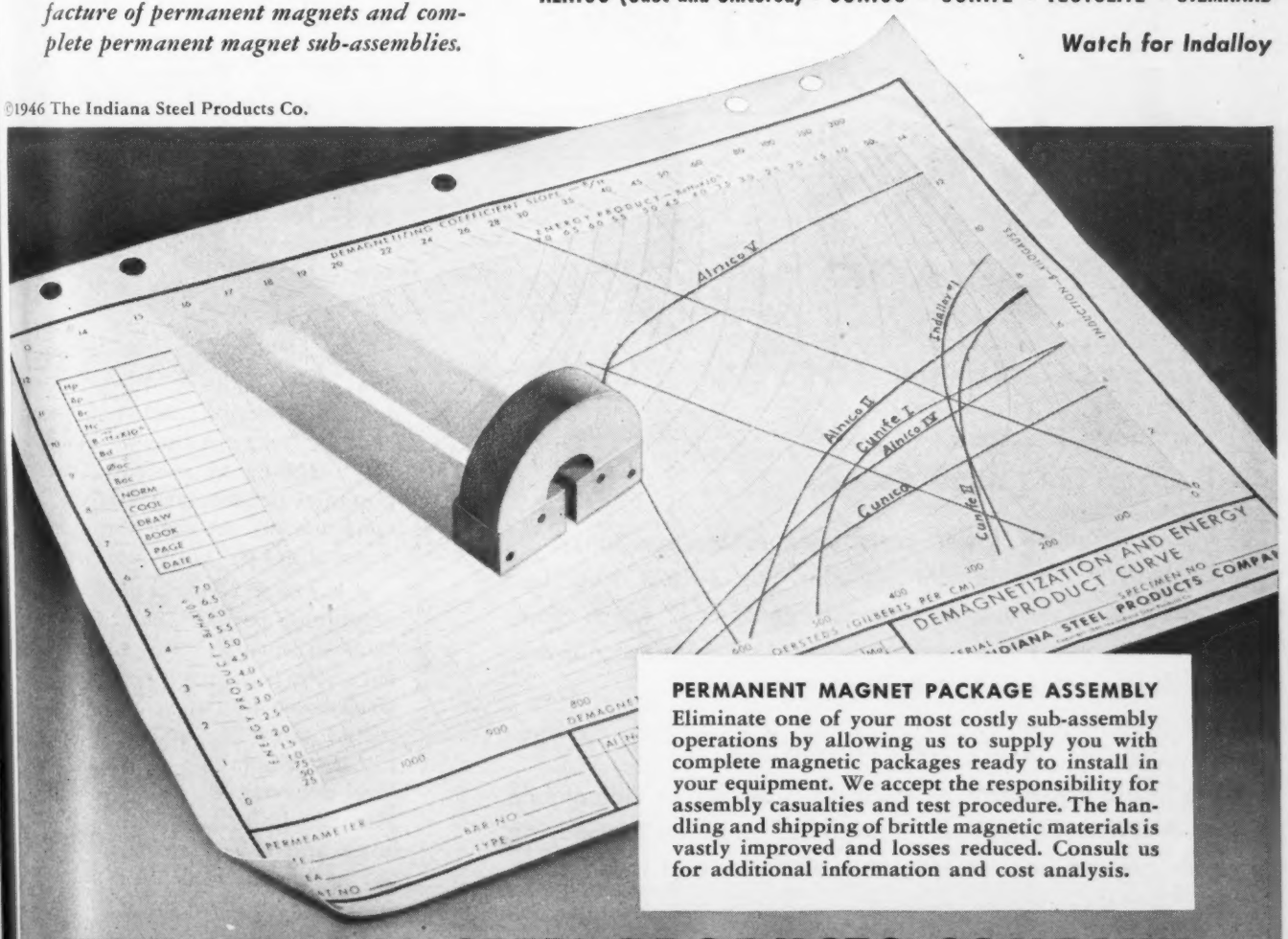

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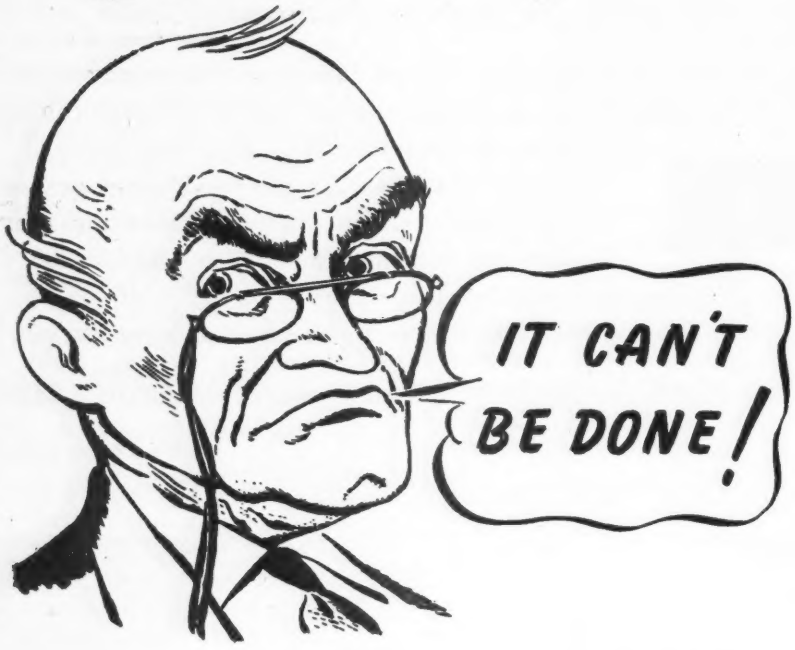

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PORTABLE CAMERA CHAIN

(*Continued from page* 31)

plane cockpit radar indicators, with relatively high illumination on its face. A simple multivibrator type triggered sweep is used, displaying up to two complete lines or frames, so that blanking levels and waveform content may be readily examined.

Cathode followers are used in connection with a three-position signal selector switch, so that either the input signal from the camera, less blanking, or the line output signal, with blanking, can be observed without "bumping" or disturbing the signal being examined. In addition a "test" position is also provided. The video waveform monitor is arranged to have a separate test input jack so that it may be used for "on location" maintenance work when required.

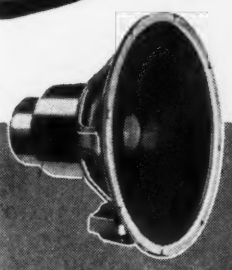
Simplified Controls

In operating, the cameraman is responsible for only optical focus and iris control. The remaining electrical focus and bias adjustments for the pickup tube appear as remote adjustments at the camera control unit. Four controls have been found sufficient; (a) photocathode focus of the electron image in the image section; (b) the electron beam focus in the scanning section; (c) beam current by varying the G_1 bias and (d) blanking by control of the dc potential on the target mesh, and consequently the net charge on the glass target in the pickup tube.

It is indeed remarkable that such acceptable performance can be obtained from this pickup tube with only four basic operating controls. Even these do not have to be adjusted often, once a satisfactory picture is obtained, if the lighting level does not change significantly. The remaining controls, pedestal level, and video gain, are brought out as knobs since these controls are used somewhat more frequently. The only operating controls for the picture tube monitor are focus, brightness and contrast.

The video amplifier section receives video from the camera head and amplifies it to a 2.0 volt level for transmission to a relay trans-

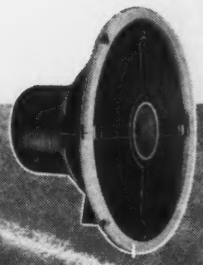
Listen...IT'S A Jensen SPEAKER!



Model HNP-51
(15-inch)

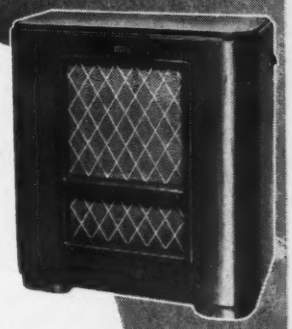
Model JAP-60
(15-inch)

Model JHP-52
(15-inch)



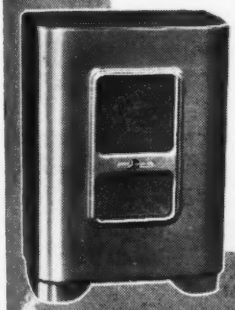
Model JCP-40
(12-inch)

JENSEN BASS REFLEX* REPRODUCERS with COAXIAL SPEAKERS



TYPE "RD"

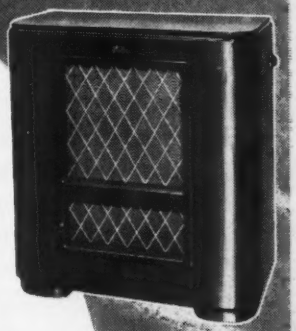
REPRODUCER NO.	STOCK NO.	CABINET NO	SPEAKER NO.	IMPEDANCE, OHMS	LIST PRICE
RD-122	ST-159	D-121	JCP-40	6-8	$120.00
RD-151	ST-160	D-151	HNP-51	500-600	212.00
RD-152	ST-161	D-151	JAP-60	500-600	164.00
RD-153	ST-162	D-151	JHP-52	500-600	151.00



TYPE "RA"

RA-124	ST-134	A-121	JCP-40	6-8	$ 76.45
RA-151	ST-136	A-151	HNP-51	500-600	177.40
RA-153	ST-138	A-151	JAP-60	500-600	128.90
RA-154	ST-139	A-151	JHP-52	500-600	115.90

JENSEN BASS REFLEX* CABINETS



TYPE "D"

MODEL NO.	STOCK NO.	SPEAKER SIZE	DIMENSIONS			LIST PRICE
			HEIGHT	WIDTH	DEPTH	
D-121	ST-156	12"	27⅞"	31⅜"	13⅜"	
D-151	ST-157	15"	27⅞"	31⅜"	13⅜"	

TYPE "A" (Finished)

A- 81	ST-123	8"	24"	18"	9¼"	
A-121	ST-124	12"	27"	24¾"	13½"	
A-151	ST-125	15"	32⅜"	27⅜"	13½"	

TYPE "A" (Unfinished)

A- 82	ST-145	8"	24"	18"	9¼"	
A-122	ST-146	12"	27"	24¾"	13½"	
A-152	ST-147	15"	32⅜"	27⅜"	13½"	

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(Pat. Applied For)

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Precious Metal Tip

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Made in Two Models The "QT" Cartridge is available with either precious metal tipped needle, Model QT-M, or with jewel tip, Model QT-J. Both needles are REPLACEABLE, easily inserted or removed. MATCHED to the cartridge, they are the only needles that can be used with it, thus assuring that the quality of reproduction will remain constant regardless of needle replacement.

LITERATURE IS AVAILABLE

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ASTATIC
CONNEAUT, OHIO
IN CANADA: CANADIAN ASTATIC LTD., TORONTO, ONTARIO

Astatic Crystal Devices Manufactured under Brush Development Co. patents.

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mitter or similar facility. If the unit is used as part of a single camera chain, sync is also mixed with the video in this section; alternatively, if it is part of a multiple camera chain, the video signal output is furnished less synchronizing pulses. A toggle switch is provided for either multiple or single camera chain operation.

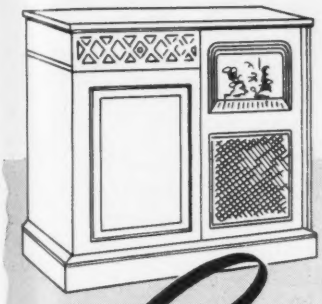
Input Attenuator

Two features of the video section are of interest, the video input attenuator and the line-to-line clamping circuit. A simple low impedance input attenuator is used, but since the cathode follower driving the line is not dc isolated, steps must be taken to ensure that the dc voltage difference observable across the input potentiometer is not transmitted to the video amplifier when rapid changes in gain setting are made.

If this is not done, the transient caused by such rapid gain changes may paralyze the succeeding amplifier stages and make gain changes on a program channel a difficult operation. This effect, often termed a "BOP", is eliminated by the use of the "NO-BOP" circuit, Fig. 9. Here, although a variation in signal level exists across the potentiometer, the dc potential at both ends of the potentiometer is the same, so that a transient cannot be introduced into the system. In this circuit it is not possible to achieve unity gain; the particular circuit of Fig. 9 giving a maximum output of only 95% of the input signal, or a loss of about one db in voltage.

The choice of circuit to provide a line-to-line clamp brought interesting parallels to the clamping technics. Of the various types of triode and diode clamps used in electronic PPI circuits in radar applications, the four-diode clamp shown in Fig. 10 has definite merits. It provides a very low impedance clamp, balancing difficulties are relatively minor, and takes no power from the source being clamped. Through the use of a clamp, the low frequency response limitations on preceding video amplifier stages are somewhat eased, and introduced additive hum is effectively removed. In addition,

And now—**Kilovolt ratings matching the elevated peaks and transients of television and other cathode-ray tube circuits . . .**



Typical high-voltage ratings—Series "84" tubular paper capacitor rated at 10,000 volts DCW, and Series "89" midget oil-filled tubular rated at 3500.

Aerovox EXPANDED-VOLTAGE RANGE *Capacitors*

Series "14" oil-filled capacitor, usually with single pillar terminal, now available in double-ended design for maximum insulation at higher potentials. This and the popular Series "12" double-pillar ribbed-cap oil capacitor, are available in voltage ratings up to 10,000 volts DCW.

• Before and since the advent of the first practical television receiver in 1939, Aerovox capacitors have marched along with the television pioneers.

Inherent Aerovox quality, PLUS Aerovox extra-generous safety factor, has successfully met the surges and transients, the heat and the humidity, and the other trying conditions of the twilight zone of television development. And that goes likewise for the severe service requirements of cathode-ray oscillography.

With larger and more brilliant screen images calling for still higher working voltages, Aerovox is again ready with expanded voltage ratings. The Series "84" paper tubulars, the Series "89" midget oil capacitors, the Series "14" and other can-type oil capacitors are now available in higher voltage ratings to meet post-war television, oscillograph and other electronic needs.

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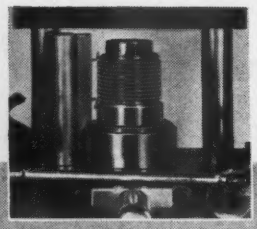

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3 Rotor assembly, supported on two bearings, assures long life and low torque.

4 The Gibbs 10 turn Micropot has terminals *moulded-in* as integral part of housing.

5 Ends of resistance element *soldered* to terminals *before moulding.*

6 Anti backlash spring in contact guide—assures you positive setting and resetting.

7 The 43½" length of resistance element gives you a finer resolution.

8 Resistance output is directly proportional to shaft rotation through a full 3,600 degrees within ± 0.1%. Such results are obtained by precision manufacturing and methods.

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GIBBS DIVISION
THE GEORGE W. BORG CORP.
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by clamping to the black level available during the local blanking interval, very little adjustment of the pedestal control is needed for a fairly wide range of scene conditions, since this black level corresponds very nearly to an absolute black level.

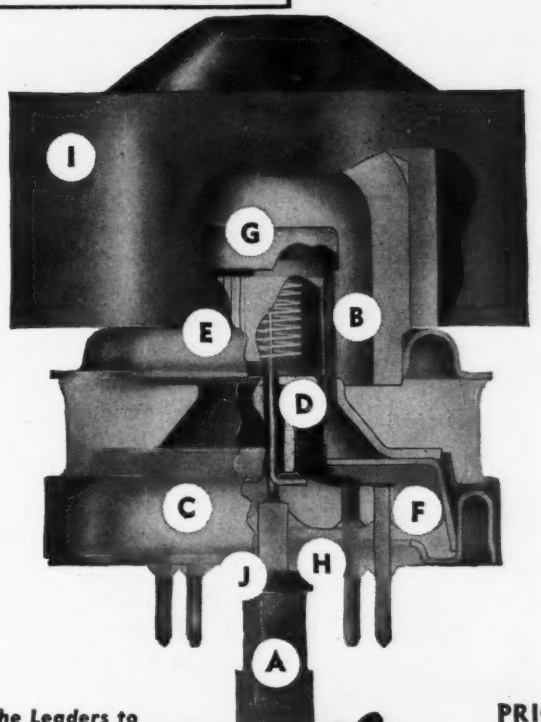
Clamping Circuits

In Fig. 10 the three half sections of the 6J6 tubes act as trigger tube and horizontal blanking oscillator. Positive and negative current pulses derived from the low resistances in the cathode and plate circuits furnish driving pulses for the clamp. When the driving pulses occur, all four diodes conduct providing a rapid discharge path for the 500 mmfd coupling capacitance. For the interval between driving pulses, the diodes are nonconducting, and the effective grid impedance for the 6AK5 video amplifier is very high. Since the coupling capacitance is discharged at the end of each line, the time constant consisting of the product of the coupling capacitance and the forward clamp impedance plus the source impedance need only be long compared to the line interval. (approx. 64 microseconds).

The mixer amplifier and monitor, Fig. 11, used for the operation of a multiple Image-orthicon chain is similar in appearance to the camera control and monitor unit. It incorporates a sufficient number of channels to handle a four-camera chain adequately. It provides (1) a 7 in. picture monitor for monitoring the signal actually being sent out "On-The-Air"; (2) a 3 in. waveform monitor for accurately monitoring the amplitude of the video and synchronizing signals constituting the output of the line amplifier; (3) for mixing the synchronizing pulses with the video signal whenever more than a single camera chain is employed; (4) a four-channel line amplifier, each channel being controlled by a pushbutton switch and a separate manual gain control, and (5) finally, an automatic fade and lap dissolve circuit so arranged that when switching between pictures, either a fade or lap dissolve may be automatically accomplished with an optional choice of four rates of change.

UHF tetrode

Eimac 4X150A Power Tetrode		
Electrical Characteristics		
Heater voltage	6.0	volts
Heater Current	2.7	amps.
Grid-screen amplification factor (approximate)	4.	
Direct interelectrode capacitance (typical)		
Grid-Plate	0.02	μμf
Input	12.0	μμf
Output	4.6	μμf
Maximum Ratings		
DC Plate voltage	1000	volts
DC Plate current	200	ma.
Plate dissipation	150	watts
DC Screen voltage	300	volts



The 4X150A, a new Eimac tetrode, extremely versatile—diminutive in size, will fill the bill in all types of application and at all frequencies up to 500 mc. Performance characteristics include — high transconductance, low plate voltage operation, low grid drive, high plate dissipation, and traditional Eimac-tetrode-stability. Physical features include:

A Low inductance grid lead.

B Close element spacing for UHF and high transconductance.

C Screen grid, mounting, and ring connector design effectively isolates input and output circuits.

D Heater isolated from cathode.

E Indirectly heated cathode.

F Low inductance cathode terminals, (four separate paralleled pins).

G Controlled primary and secondary grid emission, by specially processed grids.

H New molded glass header, precision pin alignment.

I Forced air cooled (vertical finned).

J Simple installation, adaptable to standard loctal socket.

You will find the 4X150A suited to your requirements, whether for wide-band low-efficiency service such as television video and audio or conventional application. For further information on this new, versatile, Eimac tetrode, type 4X150A, write to:

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MACALLEN Mica

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The picture monitor and waveform monitor sections of this unit are identical to those in the camera control unit. The synchronizing information video signal mixer is conventional, having pentode amplifiers with a common plate load resistor.

A four-pentode common plate, permitting the use of an automatic fading circuit, is shown in Fig. 12. In switching, for example, between Channel (a) and Channel (b), the technic is to increase gradually the bias for the amplifier passing Channel (a), and reduce the bias for the amplifier passing Channel (b) information. By controlling, through the use of RC circuits, the rates of rise and fall of these bias voltages, the automatic fading between channels is readily accomplished.

Lap and Fade Technic

If the cross-over potential is arranged to fall in such position that a period exists during which both tubes are conducting, a "lap dissolve" (Fig. 13) is obtained, wherein the two pictures are mixed for a brief period during the transition. Alternatively, if the cross-over voltage is arranged to fall at the effectively zero gain position for both channels, then the video signal appears to fade to black during the transition period; this has been designated as a "fade". The synchronizing signal is added subsequent to this mixing so that no loss of synchronizing information is involved during switching operations.

When used in the "Instantaneous" position, the relatively rapid change of plate current caused by cutting one tube off and turning another on would normally be such as to introduce a "bop" into the system. However, the input to the cathode follower comprising the output stage of the line amplifier is operated on by a line-to-line clamp which effectively eliminates this incipient "bop". The clamping circuit itself is similar to that used in the camera control unit. The manual gain controls can be used for manual fades by pressing a button marked "Manual Mixing", which effectively opens all channels. Dead channels are conven-

iently set up by running the manual gain controls to the zero positions, and manual mixing may then be accomplished by manipulation of the two or more remaining open channels. The operation of selecting any given channel energizes a cue light system, informing both the cameraman and the camera control operator associated with the selected camera chain that that particular camera signal has been selected for "On-The-Air" use.

The monitoring of the signal level of the output channel is facilitated by the use of a dc restorer associated with the video deflection circuit of the 3 in. waveform monitor. The restorer is arranged to make the tips of the synchronizing signal occur at a fixed position on the face of the 3 in. oscilloscope, thus making it possible to use fixed scribed lines on the tube face mask to indicate the appropriate 25% synchronizing level and 75% picture level. Changes in gain setting do not require readjustment of the vertical centering control to maintain this condition.

Low Voltage Supply

The low voltage supply, Fig. 14, is a relatively conventional unit operating from a nominal 117-volt, 60-cycle line. It is used within about eight feet of its associated monitor and control unit. It supplies regulated voltage power directly to the Control Unit and supplies unregulated power for the camera and viewfinder; the regulators for these latter supplies being contained in the auxiliary unit. Provision is made for the operation of the unit from 105 to 125 volts through the use of autotransformer connections on the power supply transformer.

The distribution amplifier and low voltage supply pictured in Fig. 15 are intended to supply the dc power necessary for the operation of the mixer amplifier and monitor, as well as serve as a distribution point for the sync generator. The signals normally supplied to each camera chain are composite blanking, camera driving pulses, and synchronizing pulses. The associated video coaxial line from any camera chain likewise returns to this unit; thus there are four

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As a result of a study of instrument rectifier sales to test equipment manufacturers, Conant is now able to offer you 3 rectifier package assortments for balanced buying. Whatever your volume of business, one of these assortments will enable you to purchase instrument rectifiers with the assurance that your stock on hand will always be properly proportioned.

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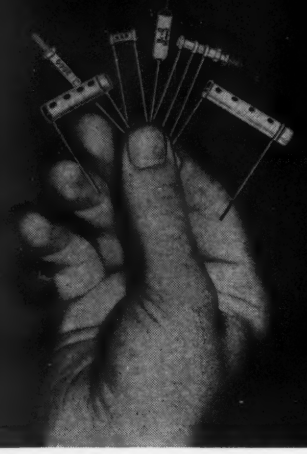
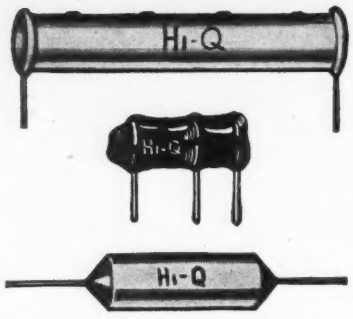
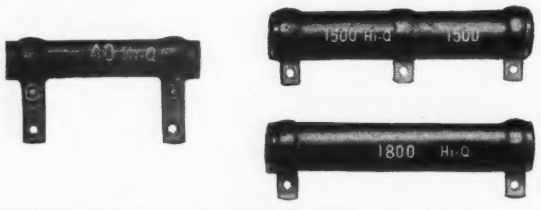


● **Hi-Q Ceramic Capacitors are manufactured of titanium dioxide (for temperature compensating types). Electrodes are of pure silver, precision coated. They are individually tested for accuracy of physical dimension, temperature coefficient, power factor and dielectric strength. Available in C. I. type (axial leads) and C. N. type (parallel leads) also S. I. type Durez coated for fullest protection against extremes of fungus and climatic conditions.**



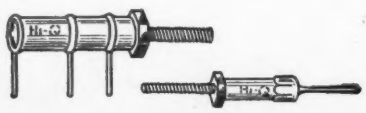
OTHER Hi-Q COMPONENTS

WIRE WOUND RESISTORS



CHOKE COILS

STAND-OFF CONDENSERS



Hi-Q ELECTRICAL REACTANCE CORPORATION
FRANKLINVILLE, N. Y.

multi-conductor plugs associated with the distribution amplifier and low voltage supply, one for each camera chain. The necessary cathode followers for complete isolation of all camera chains of a multiple hookup are likewise included in this unit which in effect serves as a master junction box for a multiple system.

Portable Sync Generator

The portable sync generator, as shown in Fig. 16, represents a radical departure from conventional designs containing a great many new components and circuit technics.

It is believed that this sync generator achieves new heights in performance with respect to constancy of pulse width, pulse rise-time, counter chain adjustment, and over-all performance, and seems to represent the smallest commercially available synchronizing generator which meets the basic RMA standards.

Diode-stabilized multivibrators make up the four-stage counting chain timer. It is possible to change tubes in the counter section without readjustment of the counting controls. The type 6AS6 coincidence tube finds extensive application in the shaper portion of the sync generator, enabling new simplicity of design to be engineered into the shaper circuitry. Miniature delay lines and diode stabilized pulse generators provide constant pulse width for tube changes. Fig. 17 shows the inside construction of the unit, the hinged chassis comprising the shaper unit, a type of construction providing easy servicing.

Recent advances give reason to believe that such equipment will find extensive use in the future not only for field operations but for small scale studio operations as well. Although it appears at present that the signal/noise ratio of the picture obtainable with this equipment is somewhat inferior to that obtainable with an Iconoscope, its sensitivity and flexibility

WHAT'S NEW
PAGES 72 TO 90

in other respects seem to more than offset this shortcoming. The Allen B. DuMont Laboratories have had extensive operating experience with this equipment in operations extending from Detroit to Cuba.

The equipment described was developed in an extremely short space of time, and this would not have been at all possible without the invaluable assistance of the staff of the studio facilities group. J. H. Mulligan, Jr., served as assistant project engineer, developing the power supply equipment and, with A. Talamini, the portable sync generator; E. E. St. John the camera, viewfinder and camera auxiliary units; and G. M. Glasford the camera control and mixer amplifier equipment. The packaging of this equipment is due to E. M. Usher and J. Hicken, all of these laboratories.

INTERPHONE SWITCHES

(*Continued from page* 44)

short that it is ineffective between syllables. Should the listener on channel II commence speaking at such an instant, the current generated in his microphone will effect the necessary switching. The plate current of tube T_4 will be amplified in the auxiliary amplifier T_5, rectified by R_6 and used to block the plate current of tube T_2 in channel I. This will permit tube T_3 to carry current and channel II will be in operative condition. Switching is practically instantaneous, and closing of channel I precedes opening of channel II, which it causes, assuring reliable and speedy performance.

In very noisy locations, an external noise may cause momentary interruption of a channel. This can be prevented by the insertion of filters or by compensation methods. It is feasible in any of these circuits to control the loudspeaker excitation current instead of the tube current; however, a considerable current intensity would be required.

Taylor Fibre Expands

Taylor Fibre Co. has opened a West Coast plant at La Verne, Calif. Its Eastern plant remains at Norristown, Pa.

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Heavy Flange for mounting Wave guide ...	2.00

3 CENTIMETERS

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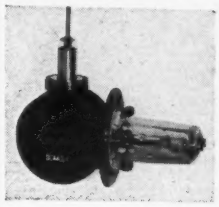
Wave guide, 18" long S curve, cover to choke	3.50
Rotary coupler, wave guide in and out, choke to choke	6.00
Duplexer section using 1B24	10.00
Wave guide 5 ft. lenghts, per ft	1.95

1.25 CENTIMETERS

T section choke to cover	$ 4.50
Flexible section choke to choke	3.00
Miltered elbow and "S" section cover to choke	3.50



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3J31's One cm magnetron listed at $95.00. OUR PRICE.. $20.00

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McNALLY KLYSTRON 707B. 10 cm	9.95
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Magnet for 3 centimeter magnetrons, incorporating a magnetron stabilizer cavity	
Cinaudagraph Type UC 210	22.50
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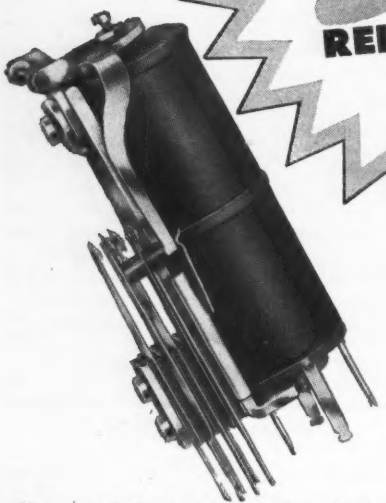

Clarostat telephone type relay. Great flexibility because of large variety of contact arrangements. Long life—many millions of operations. High sensitivity. Coil values up to 11,300 ohms. Available in long and short types.

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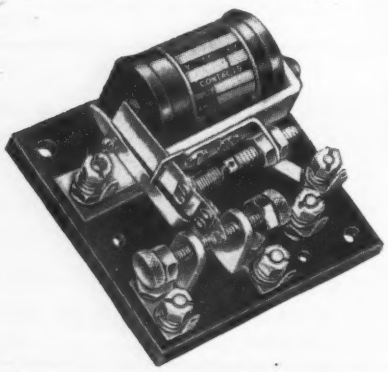
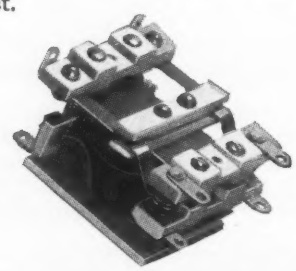
Clarostat has an engineering staff of *relay specialists* second to none. These men have many years of experience in relay problems and solutions. They have built and supplied tens of thousands of relays of all types now found in the finest assemblies. Likewise midget synchronous motors for clocks and time switches. Therefore...

Let Clarostat Solve Your *Relay* Problems, too! Submit your problems and requirements. Literature on request.



Clarostat sensitive relay. High-permeability nickel alloy. Normally adjusted to 14 milliwatts D.C. sensitivity, can be increased to 3 milliwatts. Coils up to 30,000 ohms. A.C. sensitivity of .35 VA at 60 cycles, or 0.5 VA at 25 cycles. Power factor of .4 and .25, respectively. Chatterless operation – suitable for high-speed keying.



Clarostat ceramic relay featuring non-hygroscopic, low power-factor steatite insulation of 5000 v. to ground. Required input 2 watts D.C. or 4 VA A.C. Contacts good for 10 amperes. Coils up to 10,000 ohms.

CLAROSTAT Controls and Resistors

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VHF RADIO EQUIPMENT SPEEDS RAILROADS

(*Continued from page* 41)

transmitting on a frequency only 120 kc off this receiver's frequency without a trace of interference. Ten watts of audio output provides sufficient volume to blast over the very high noise level existing inside the cab of a steam locomotive.

On diesel locomotives, radio installations are similar except that dynamotors for operation from 64 or 115 volts dc are used. In caboose installations, electric power usually is obtained from a 32-volt battery with or without a wheel-driven generator. Gasoline, propane or diesel engine driven alternators are sometimes used to supply 115 volts at 60 cycles in which case the dynamotor is replaced by a rectifier-filter type of power supply.

Power Supplies

Some railroads are considering the use of ac power supplies in all of their mobile installations. Steam driven turbo-alternators supplying 115 volts at 60 cycles would be used on steam locomotives. Where batteries are used as the primary power source, a converter will be used to supply alternating current.

In yard operation, it is often important to provide communication between yard master and yard conductors who are on foot or riding on the step of switch engines. A remote control unit can be provided for installation on the front or rear of a locomotive. From this point, the yard conductor is provided with loudspeaker inter-communication facilities to the engineman as well as control of the mobile radio equipment. The remote loudspeaker is used as a talk-back microphone. Switching from "receive" to "transmit" is accomplished by operating a knee switch.

A typical land station consists of a biconical antenna, communications unit, power supply and control unit. The communications unit is identical to those used on locomotives and is also installed in a sealed metal case. The control unit is designed for desk mounting. Its built-in loudspeaker is

used as a talk-back microphone. If desired, a handset may be used, in which case lifting the handset from its cradle cuts off the loudspeaker. A conventional rectifier-filter type power supply is used.

Remote control units are similar to the master control unit but include a line amplifier. The land station may be operated from any of the remote dispatch points. In addition, loudspeaker intercommunication between control points without putting the transmitter on the air is provided. A metallic pair telephone line is used to interconnect dispatch control units. All of this specialized equipment is designed specifically for railroad communications.

The Federal Communications Commission has assigned 60 channels from 158.43 to 161.97 megacycles for the exclusive use of the railroads. The Association of American Railroads has prepared a list of recommended frequency assignments for the nation's principal railroads. The road is clear and many railroads are adopting radio communication to provide increased efficiency, greater convenience and added safety.

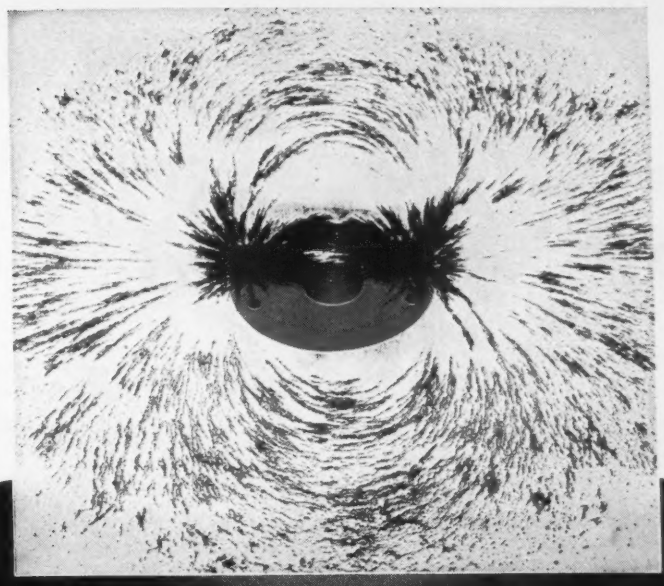
TELE-COMMUNICATIONS

(*Continued from page* 92)

will be manufactured and purchased to warrant the expense incurred by CBC.

Sale of American FM sets, however, is said to be almost impossible in Canada because Canadian Radio Patents Ltd. controls the Canadian radio market and any import of sets would be considered a patent infringement by that company. Comparably, Thermionics, Ltd., controls the radio tube business in that country. Added to these barriers of FM equipment exports to Canada are the heavy taxes to which all radio equipment there is subject. These include levies of 10% for revenue 25% duty tax and 8% sales tax.

No statistics have been gathered on FM receiver manufacturing in Canada but it is expected that production in that field will greatly increase this year. Last year, Canada's production for all types of receivers amounted to 550,000 sets.



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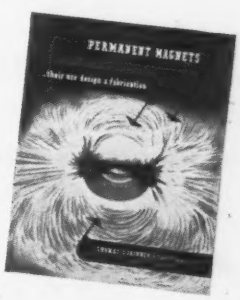

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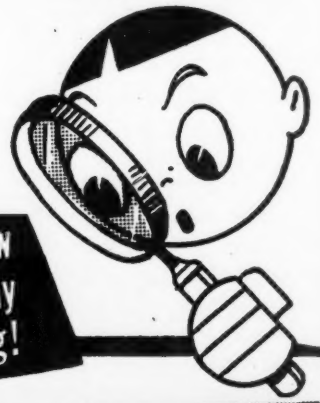

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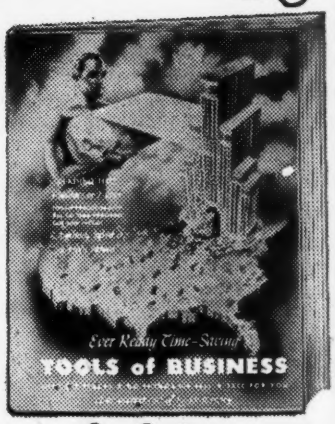

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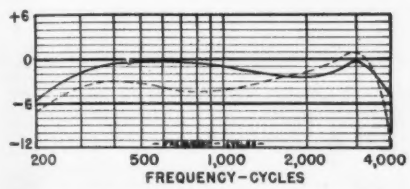
SOUND RECORDER

(*Continued from page* 51)

plitudes it is like a widened slit. This decrease of the stylus contact is a great advantage if the amplitude is small enough. However, the smallness of the useful recorded amplitude is limited, as aforementioned, by the surface noise of the disc material. A further limitation to an extremely low level surface noise material would be the practical factors of scratches, clicks, etc. which are inevitable in practical use.

In addition, the shallower and smaller the groove can be, the smaller the stylus point radius engaging the groove edge can be, and the easier it is both to register and reproduce high frequencies. In addition, the narrower the groove, the larger the high level recorded amplitudes can be. The limit of smallness of the groove is the minimum groove dimension in which the pickup will track as well as the minimum practical stylus dimension which will still give adequate ruggedness. Groove dimensions used are compared in Fig. 7 to a high standard phonograph groove.



Frequency response of reproducer unit

Obviously, the playback characteristics to get tracking of these shallower grooves demand a pickup head and arm much more highly refined than are standard phonograph types. The pickup head of SoundScriber dictation machines has a moving coil, very flexibly mounted for extremely high needle compliance. The mounting of the head in the arm is of importance as well as the arm mounting. The head is hinged in the arm not far from the needle point to give the low mounting inertia necessary to quickly follow turntable rise and fall, disc irregularities, etc.

One factor in tracking disc grooves on Navy equipment, as well as commercial equipment, that affects the arm design is that

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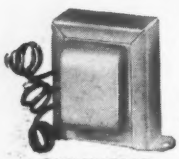
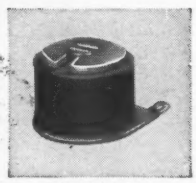
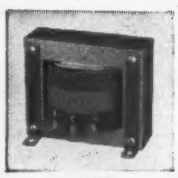


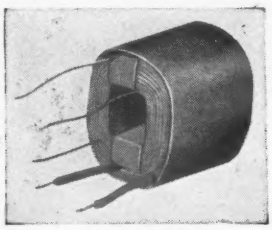
LOW VOLTAGE TRANSFORMER



RELAY COIL



POWER TRANSFORMER



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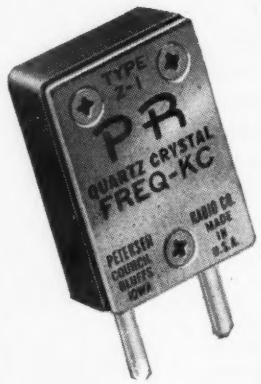

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these machines might not be set up perfectly level. It was therefore important to design the machines to record and reproduce satisfactorily off-level. The recording problem was simple because the frictional drive of the recording head is under sufficient pressure.

However, the playback arm being on a free moving axis, was susceptible to the pull of gravity. A lateral counterbalance for the whole recording arm was introduced in order to compensate for its lateral gravitational component. (Fig. 10). This enabled the machine to playback satisfactorily.

Other features a pickup must have to playback these shallow grooves satisfactorily are complicated. The pickup must, as far as possible, be free of the forces which oppose the propulsion of the stylus across the record surface by the groove itself. These forces are: (1) the friction at the pivots of the playback arm, (2) the sideways components of the frictional force between the needle and the disc, (3) the off-level gravitational forces overcome by the counterbalance and (4) instantaneous lateral forces from sharp undulations in the recorded groove which become transmitted to the arm itself. This being accomplished by the highly flexible needle movement.

The reaction of point friction is largely a matter of very careful refinement but the factor of the sideways components of the frictionable force usually is not considered with disc pickups. This factor may be unimportant with standard phonographs but it is important to this pickup because of its necessarily short length and the off-tangency to the groove. Reference to Fig. 8 will show the neutralizing spring used for the purpose of compensating for the sideways components of the friction between stylus and disc.

The more the playback pickup can be freed from the retarding forces the smaller the groove can be that it will still track. The smaller the groove can be, the better the frequency and volume range at a given groove speed, and also the greater the modulation without cross-talk.

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SPEECH CLIPPING

(*Continued from page* 65)

when using a good quality dynamic microphone, was found to produce negligible apparent distortion. At 25 db clipping, the speech was definitely distorted but somewhat louder than at 20 db. It was felt that this was too high a level and all further tests were made with 20 db of clipping.

The next test was to determine the average apparent increase in signal level for 20 db of clipping. A signal generator was modulated by the PLEX amplifier and its output fed into a standard communication receiver. With AVC off, the receiver gain was reduced until unclipped speech was just understandable. 20 db of clipping was then added and the calibrated attenuator on the signal generator was varied until the speech had the former apparent loudness. The change in signal generator output, representing the power gain, varied from 10 db to as much as 14 db with an average of about 12 db for a number of different observers. This compares favorably with a scientifically conducted test using trained readers and a large group of observers which was carried out by J. C. R. Licklider at Harvard.[8] The gain ratio was unchanged when noise was introduced into the receiver input.

To obtain a comparison with a compression type amplifier a similar test was conducted with a standard broadcast type compressor. The compressor recovery time was shortened up to about ¼ second to allow the gain to be maximum for as much of the time as possible. In spite of this the best improvement which could be obtained was 4 to 6 db. However, the gain of the compressor increased about 3 db at the 20 db compression level so that the net improvement was only 1 to 3 db! Added to this is the disadvantage that the attack time of a compressor, while it may be made very short, is finite thus making some overmodulation almost inevitable.

A study of the effect of falling low frequency response in the following amplifier or modulator stages was made by actually modulating a 300-watt transmitter.

The frequency response at the output of the modulator was down 3 db at 100 cps causing quite marked distortion of the square tops. Modulation level was adjusted in the mid range to approximately 85% without clipping.

With 20 db of clipping applied, the carrier envelope was examined with an oscilloscope. Carrier cutoff on the negative peaks was observed to start a little below 300 cps and becomes more pronounced at lower frequencies. It is carrier cutoff which usually causes the worst adjacent channel interference due to the abruptness with which it occurs. In this case, however, a careful examination of the pattern showed that the clipper itself was controlling the corners and only the distorted center section of the square top was causing carrier cutoff.

Advantage of Clipping

In other words the angle at which the speech wave crossed the cutoff line was much less than 90 degrees hence no troublesome splatter was caused. Indeed the modulation pattern had almost the same wave shape as the original clipped wave after it had passed the low pass filter. Obviously, then, no components were being introduced above 4000 cps.

A contact was made over a 120-mile circuit using this transmitter to determine the advantage of clipping under actual operating conditions. The receiver was operated without AVC and the readibility of the signal was reported back as both the degree of clipping and the carrier power were changed. For this test the depth of modulation was set, using an oscilloscope, until definite overmodulation was present on some of the peaks in speech. This was considered by several independent observers to be the usual condition for communication work and was used in preference to absolutely no overmodulation as providing a more realistic test of the equipment.

Contact was first established with full carrier power and no clipping and transmission was continued until the reporting station had established a satisfactory reference. The power was then reduced to one third, as indicated by

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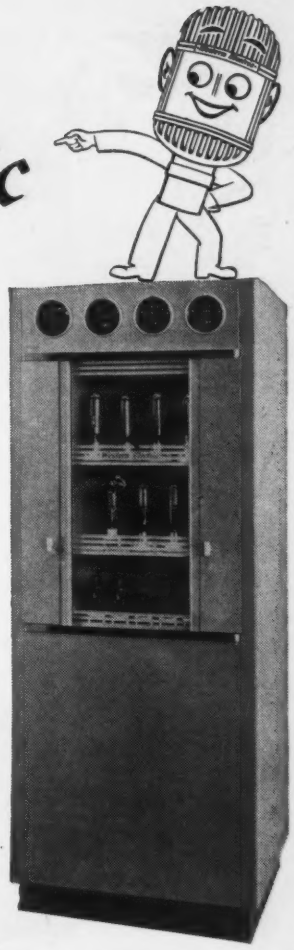

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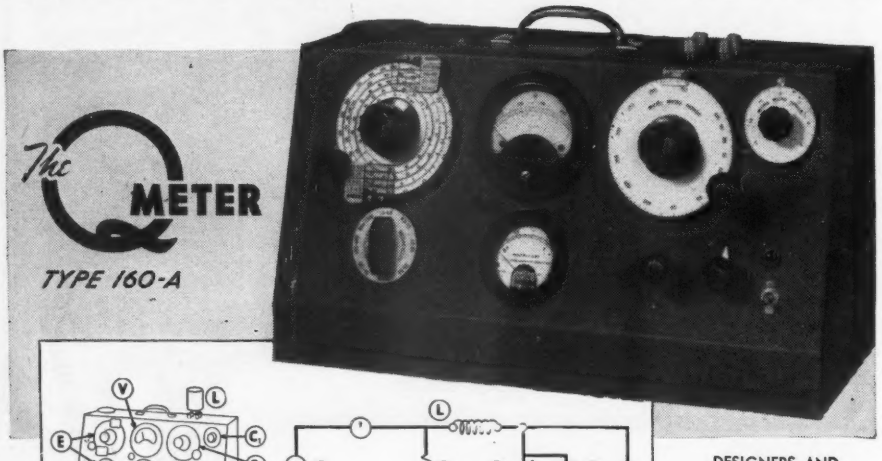

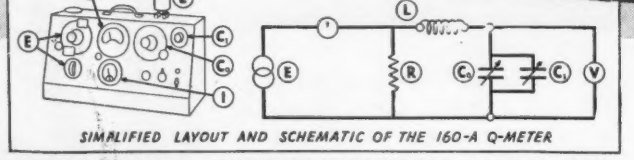

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An R.F. oscillator (E) supplies a heavy current (I) to a low resistance load (R), which is accurately known. The calibrated voltage across the load resistance (R) is coupled to a series circuit consisting of the inductance under test (L) and a calibrated variable air capacitor (C_0) having a vernier section (C_1). When this series circuit is tuned to resonance by means of capacitor (C_0+C_1), the "Q" of (L) is indicated directly by the V.T. Voltmeter (V). Variations of this method are used to measure inductance, capacitance and resistance.

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the decrease in antenna current, the modulation depth was made the same as before and 20 db of clipping was added. The report was that the signal was much better. A reduction to one sixth power resulted in a signal about the same as the original but with some fading. All the tests were repeated several times with the same results.

Power Gain

The apparent power gain of six to one, or 8 db is less than laboratory tests would have indicated but it must be remembered that some overmodulation was allowed in the first place. Licklider[8] points out that the highest peaks in the usual communication circuit overmodulate by 3 or 4 db which means that the modulation starts out that much above the level which would be required to have absolutely no overmodulation.

The latter condition was present in our laboratory setup hence 3 or 4 db greater gain was obtained. The expander, or squelch, feature was probably best demonstrated by a recording which was made to illustrate the operation of the PLEX amplifier. During part of the recording a record of office noise was mixed in as background. With the squelch off, the background noise was quite objectionable; however, when the squelch was in operation there were only occasional bursts of noise during speech and in the absence of speech the output was zero. The operate time was made less than .005 second and the release time about .05 second for best results.

In conclusion it may be said that a properly designed speech clipper will increase the effective power of an AM carrier by at least five. If the original circuit was strictly limited to no overmodulation the effective gain will be at least ten times. In any case harmful overmodulation is absolutely eliminated. The higher level which may be run makes the background noise more prominent on the carrier and if this is appreciable a squelch circuit in the speech system is advantageous. Finally a word of warning—when clipping

is used a low pass filter *must* follow the clipper.

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FMers Link 5 Cities

The makings of a new FM web, tentatively titled The Continental Network, may be in the offing. Five FM stations are to broadcast the music of the 65-piece American Air Forces Band, each Wednesday night between 8:30 and 10:00 p. m. W2XEA at Alpine, New Jersey, receives the program from WASH-FM in Washington, over a special wire line with a frequency response up to 8000 cps., no better line being available at this time. The program also is broadcast over Alpine's low-band station W2XMN on 44.1 mc and picked up for rebroadcast by two other stations. WDRC-FM, Hartford, Conn., makes one rebroadcast; WBCA, Schenectady, the other. At WBCA, the program is rebroadcast at 101.1 mc as well as 44.7 mc. The latter signal is picked up by WIBX-FM Utica, N. Y. and rebroadcast over its high band frequency making a five-station network in all.

Reception of the Alpine signal at Schenectady suffers no impairment in quality despite a transmission distance of 129 miles and the amazing fact that Schenectady's antenna is 6475 ft. below line of sight from the Alpine tower.

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FM STATIONS

(*Continued from page* 33)

Frequency modulation is highly developed; it is ready to move forward on a large scale and on a full commercial basis." Seven years have passed—four of them, war years. The comparison between 1940 FM and 1947 FM is interesting.

In 1940 there were approximately 15,000—20,000 FM receivers in use throughout the United States. Approximately 15 FM broadcast stations maintained an operating schedule, 20 construction permits had been granted, and about 40 FM applications were pending before the FCC. For comparison, the following figures are given in round numbers: Today, there are nearly 600,000 FM sets in use, nearly 300 FM stations on the air, 300 construction permits, and 500 applications for new FM stations. The number of stations whose combined coverage will saturate the U. S. has been conjectured as anywhere from 3,000 to 5,000. The consensus is the obvious observation that this number will depend upon how much the radio advertising medium can bear economically.

On the future of FM, estimates for the production of FM station equipment for the ensuing year are anywhere from $75,000,000 to $150,000,000. Sales of between 3 and 4½ million FM receivers in 1947 is the prediction by Stromberg-Carlson's president, Dr. Ray H. Manson.

Technically, FM circuitry made substantial advances—due, in part, to widespread application of FM as static-free communications for military uses. Reassignment of the FM band imposed new technical problems in the manufacture of station equipment and receivers. Generation of high FM powers at 100 mc spurred new technics in tube design and high-gain antennas.

Despite technical difficulties in the manufacture of FM equipment, in the allocation of frequencies in a crowded spectrum, in new programming technics, etc., the FM industry continues to grow rapidly as the map indicates.

FM CONSTRUCTION PERMITS

(*Continued from page 47*)

WCAO—FM—811 W. Lanvale St., Baltimore 17 ....M. L. Jones
WFBR—FM—10 E. North Ave., Baltimore 2 ....W. Q. Ranft
WBCC—FM—5 Wilson Lane, Bethesda 14 ....V. C. Story
Chesapeake Broadcasting Co., Bradbury Heights
Cumberland Broadcasting Co., 31 Frederick St., Cumberland
Tri-State Broadcasting Co., 81 Baltimore St., Cumberland
Peninsula Broadcasting Co., Radio Park, Salisbury

MASSACHUSETTS

WGTR—FM—21 Brookline Ave., B ston 15 ....I. B. Robinson
WAZV—10 Post Office Square, Brockton
Plymouth County Broadcasting Corp., 106 Main St., Brockton
WBET—FM—60 Main St., Brockton 64 ....M. L. MacAdam
WSAR—FM—Academy Bldg., Fall River...John Pavao
WEIM—FM—717 Main St., Fitchburg.....Ted Kalin
WHAI—FM—354 Main St., Greenfield..L. F. Wheeler
WHAV—FM—163 Merrimac St., Haverhill ....H. W. Brown
WHYN—FM—180 High St., Holyoke..T. R. Humphrey
Hildreth & Rogers Co., Lawrence Eagle & Tribune, Lawrence
WLLH—FM—39 Kearney Square, Lowell ....A. G. Michaels
WBSM—229 Coffin Ave., New Bedford
Southeastern Mass. Broadcasting Corp., 222 Union St., New Bedford
WMFM—25 Bank St., North Adams..J. G. Keyworth
WESX—FM—126 Washington St., Salem ....R. I. Hammond
WMAS—FM—1757 Main St., Springfield 3 ....Earl Hewinson

MICHIGAN

WATX—FM—Ann Arbor.....F. A. Nader
WPAG—FM—Hutzel Bldg., Ann Arbor..G. D. Stearns
WHFB—FM—Fair Plain Ave., Benton Harbor ....Munson Robinson
WXYZ—1700 Strch Bldg., Detroit 26...Chas. Kocher
UAW—CIO Broadcasting Corp. of Mich., 411 W. Milwaukee St., Detroit
John P. Norton, 520 Third Avenue S., Escanaba
Advertisers Press, Inc., 328 Saginaw St., Flint
Fetzer Broadcasting Co., Grand Rapids
Lear, Inc., 110 Tonia N.W., Grand Rapids
Grosse Pointe Broadcasting Corp., Grosse Pointe
WIBM—FM—228 W. Michigan Ave., Jackson ....C. W. Wirtanen
WJIM—FM—126 W. Allegan St., Lansing
WQDV—Argus Press Co., Owosso
Pontiac Broadcasting Co., 35 W. Huron St., Pontiac
Royal Oak Broadcasting Co., 212 W. Sixth St., Royal Oak
Saginaw Broadcasting Co., 610 Eddy Bldg., Saginaw

MINNESOTA

Radio Austin, Inc., Austin
WLOL—FM—1730 Hennepin Ave., Minneapolis 3 ....Gene Brautigam
KFAM—FM—18 Sixth Ave. N., St. Cloud ....R. B. Witschen
WMIN—1287 St. Anthony Ave., St. Paul
Elmer A. Benson, West St. Paul

MISSISSIPPI

WGCM Broadcasting Co., 25th Ave. Hewes Martin Bldg., Gulfport

MISSOURI

KFVS—FM—324 Broadway, Cape Girardeau ....O. C. Hirsch
Evangelical Lutheran Synod, Clayton
Capital Broadcasting Co., Jefferson City
KICR—FM—Board of Education, Kansas City
WHB—FM—Scarritt Bldg., Kansas City
KFEQ—FM—Schneider Bldg., St. Joseph
KSD—FM—12th & Olive Sts., St. Louis
KXOK—FM—12th & Delmar Sts., St. Louis 1 ....A. F. Rekart
WEW—FM—3642 Lindell Blvd., St. Louis 8 ....G. E. Rueppel

NEVADA

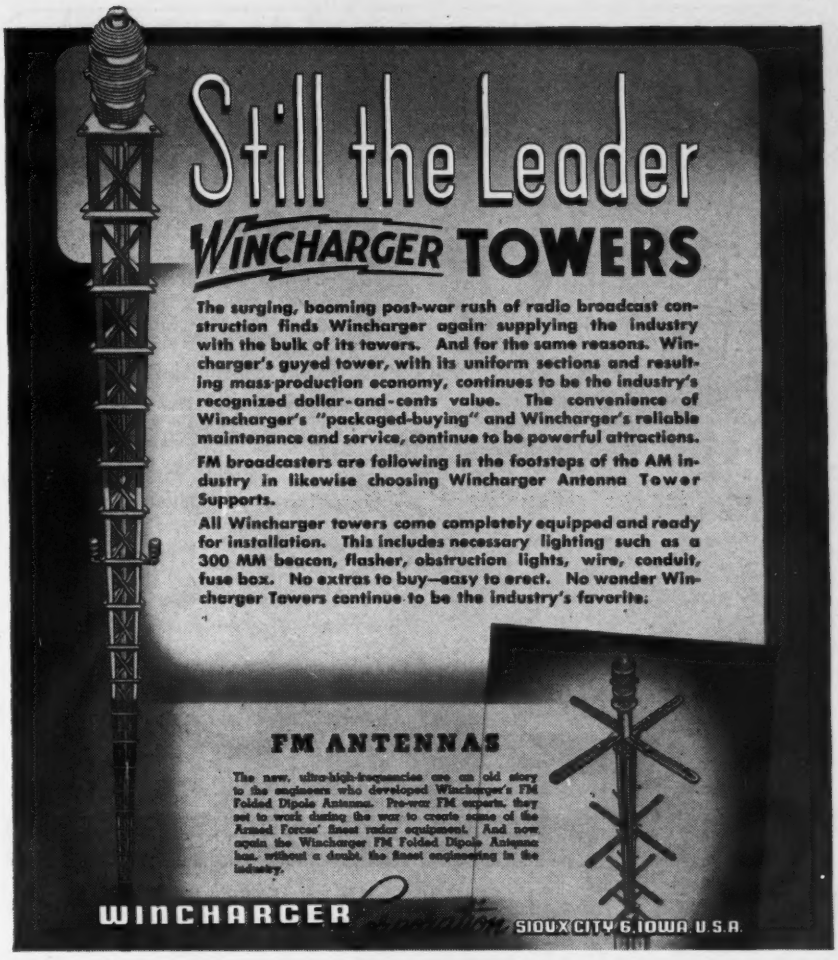
KWRN—Reno Newspapers Inc., Reno
Saviers Electrical Products Corp., Reno

NEW HAMPSHIRE

Radio Voice of New Hampshire, Inc., 1819 Elm St., Manchester

NEW JERSEY

WCAP—FM—Radio Industries Broadcast Co., Asbury Park
WJLK—Press Plaza, Asbury Park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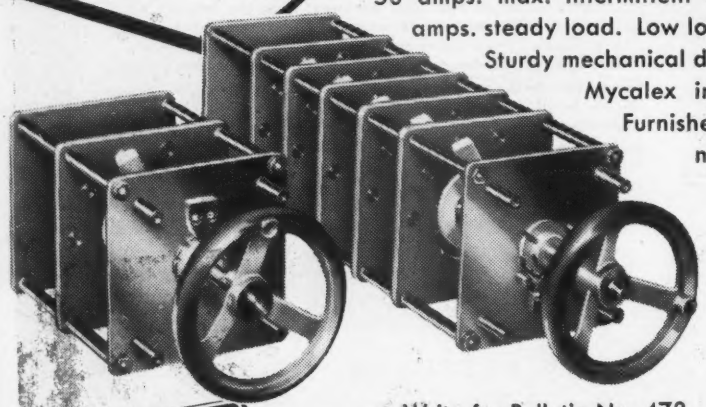

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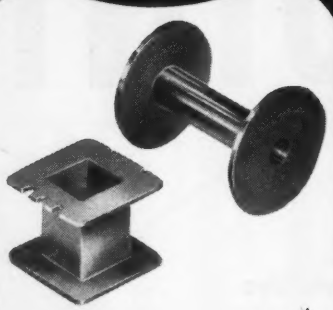

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WPOE—1143 E. Jersey St., Elizabeth 4..Wm. Maron
C. H. Winans Co., 125 Broad St., Elizabeth
WFMO—26 Journal Square, Jersey City
WBGO—345 High St, Newark 2..Dr. J. H. Schotland
Chanticleer Broadcasting Co,. 385 George St., New Brunswick
WHNM—Home News Publishing Co., New Brunswick
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WNYE—FM—29 Fort Greene Place, Brooklyn ....H. Haverkamp
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WHLI—FM—Hempstead.....F. E. Knaack
WJTN—FM—110 W. Third St., Jamestown ....H. J. Kratzert
WKNY—FM—601 Broadway, Kingston ....Herbert Inman Jr.
WMSA—FM—Central Bldg., Massena ....Michael Yonkovig
W. H Moffat, Radio New Rochelle, 49 Clove Rd., New Rochelle
Amalgamated Broadcasting System, Inc., 11 Union Square, New York
Champlain Valley Broadcasting Corp., 598 Madison Ave., New York
Hearst Radio, Inc., 25 W. 43rd St., New York 18
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National Broadcasting Co., RCA Frequency Bureau, 60 Broad St., New York
Radio Projects, Inc., 233 Broadway, New York
WSLB—Ogdensburg.....Roy Lafferty
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Burlington-Graham Broadcasting Co., State Theatre Bldg., Burlington
Inter-City Advertising Co., 120 E. Third St., Charlotte
Jefferson Standard Broadcasting Co., Charlotte
Surety Broadcasting Co., 112 S. Tryon St., Charlotte 2
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WDNC—FM—Durham Radio Corp., 138 E. Chapel Hill St., Durham
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North Carolina Broadcasting Co., O. Henry Hotel, Greensboro
WGTC—FM—Falkland Highway, Greenville ....Wm. Alford
WHKY—FM—13th St., Hickory.....E. S. Long
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WPTF Radio Co., Insurance Bldg., Raleigh
WCBT—FM—Box 190, Roanoke Rapids, N. C. ....C. W. Meares
WCEG—FM—140 Howard St., Rocky Mount ....W. G. Palmer
WSTP—FM—Piedmont Broadcasting Corp., Yadkin Hotel, Salisbury
WSIC—FM—Radio Road, Statesville..T. K. Abernethy
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OHIO

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WCPO—FM—3800 Carew Tower, Cincinnati 2 ....G. A. Davis
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Capital Radio, Inc., 42 E. Gay St., Columbus
Sky Way Broadcasting Corp., 310 W. Broad St., Columbus
WTUS—Tuscora Broadcasting Co., 350 Reporter Ct. Dover
WFIN—FM—500½ S. Main St., Findlay..E. C. Smith
L. E. Kinn, 963 N. Union St., Fostoria

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Northwestern Ohio Broadcasting Corp., Natl. Bank Bldg., Lima
Marion Broadcasting Co., Marion
Scioto Broadcasting Co., Portsmouth
Record Publishing Co., 122 N. Chestnut St., Ravena
WRRN—FM—108 Main St., Warren...R. V. Kinney
Wooster Republican, 212 E. Liberty St., Wooster
WKBN—FM—17 N. Champion St., Youngstown ....B. T. Wilkens

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Enid Radiophone Co., 114 E. Broadway, Enid
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Okla. Press Publishing Co., 214 Wall St., Muskogee
KOMA—FM—Box 983, Oklahoma City 1 ..M. W. Thomas
Sooner Broadcasting Co., 2712 First Natl. Bldg., Oklahoma City
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KFMJ—FM—Alvin Hotel, Tulsa.....N. E. Wilcox

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KSBO—FM—150 N. Main St., Ashland
Eugene Broadcast Station, Route 3, Eugene
Valley Broadcasting Co., Eugene
Southern Oregon Broadcasting Co., Box 43, Grants Pass
Medford Printing Co., 27 N. First St., Medford
KXL—FM—Orpheum Bldg., Portland 7

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WFMZ—FM—1524 Linden St., Allentown ....K. A. Rogers
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WISR—FM—357 N. Main St., Butler ..P. F. Rex
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WCED—FM—80 Park Place, DuBois...Vernon Stahl
WEST—FM—516 Northampton St., Easton ....J. W. Eckenrode
Presque Isle Broadcasting Co., 121 W. Tenth St., Erie
WLEU—FM—Commerce Bldg., Erie
WHPC—The Patriot Co., 105 N. Front St., Harrisburg
Hazleton Broadcasting Service, Hazleton
WARD—FM—237 Franklin St., Johnstown ....Walter Murawsky
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Dr. H. C. Winslow, 883 Water St., Meadville
Derrick Publishing Co., 5-7 Center St., Oil City
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WPPA—FM—8 S. Second St., Pottsville ....J. G. Thiel
WHBP—FM—30 N. Fourth St., Reading
Scranton Times, 149 Penn Ave., Scranton
WGBI—FM—1000 Wyoming Ave., Scranton 9 ....K. R. Cooke
WPIC—FM—Pine Hollow Blvd Sharon ..A. C. Heck
WKOK—FM—Sunbury Broadcasting Corp., Sunbury
WNIQ—8 Church St., Uniontown
Wyoming Valley Broadcasting Co., 88 N. Franklin St., Wilkes Barre
WRAK—FM—244 W. Fourth St., Williamsport
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WTMA—FM—133 Church St., Charleston
WIS—FM—Jefferson Hotel, Columbia ....H. G. Eidson, Jr.
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Greneo, Inc., Willson St., Greenwood
WLSC—Lancaster Broadcasting Co., Lancaster
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WDOD—FM—Hamilton National Bank Bldg., Chattanooga
M. K. Wilson, 406 Loveman Bldg., Chattanooga
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Leaf Chronicle Co., 112 S. Second St., Clarksville
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WHHM—FM—295 Union Ave., Memphis
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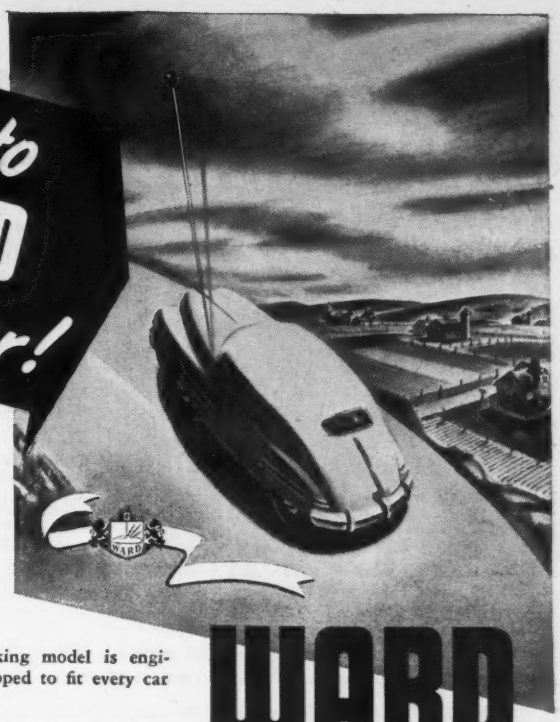

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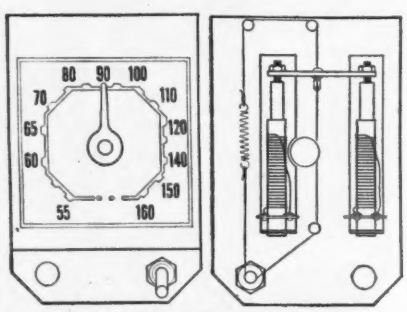

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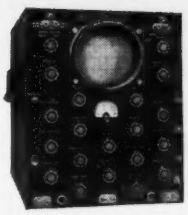

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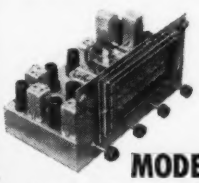

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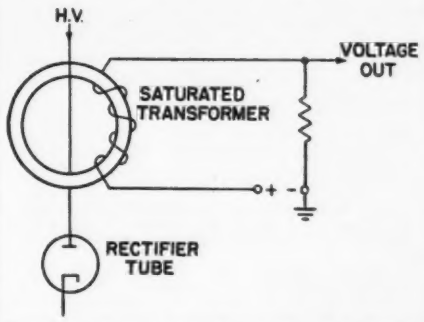
WINCHESTER, MASS.

ARC-BACK INDICATOR

(*Continued from page* 67)

tween the main anode and the cathode to break down. The discharge in the main gap is readily visible and serves as indication that the tube has been fired. If several of these tubes are operated with a common cathode resistor and one tube is fired, the current in the main gap flowing through this common resistor raises the cathodes of all the tubes to a high positive potential.

The circuit is so designed that

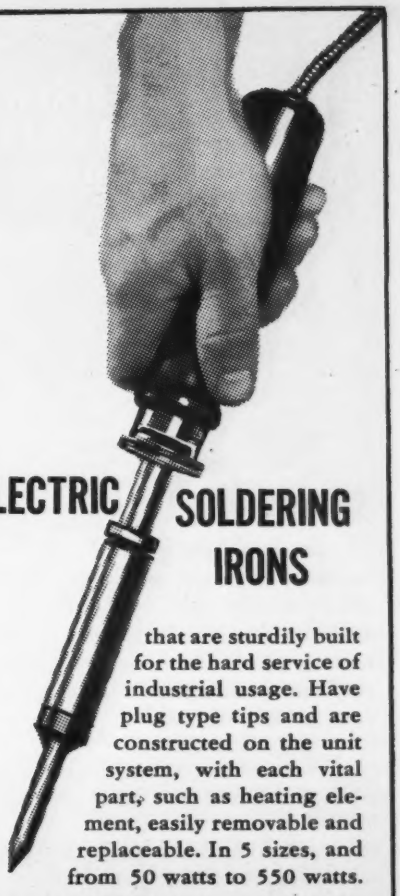


Basic fundamental of the arc-back indicator

the same amplitude of voltage pulse from any rectifier tube which may arc-back subsequently will not be sufficiently more positive than the cathodes to fire any other indicator tube. This type of indicator circuit used with the saturated transformers gives an effective arc-back indicator.

As used in the new Western Electric 10-kilowatt FM transmitter the circuit has been carried a step further. The voltage from the saturated transformer does not operate directly on the indicator tube but is used to trigger a small thyratron tube. The firing of this thyratron in turn fires the indicator tube.

The common resistor in the cathode circuit of the indicator tubes blocks all the indicator tubes except the first one to fire. A sensitive relay in the common plate supply of the thyratrons acts to open the ac power to the rectifier whenever one of the thyratrons is fired. As this sensitive fast-operating relay is the only mechanical link between the saturated transformer and the tripping circuit for the power supply, the time required to remove power in case of an arc-back is greatly reduced as compared with that required when



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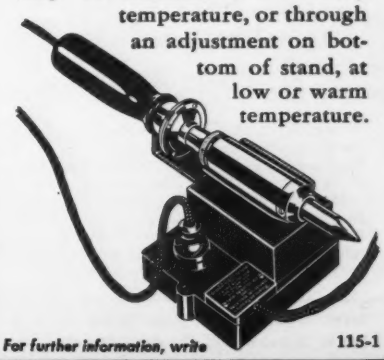

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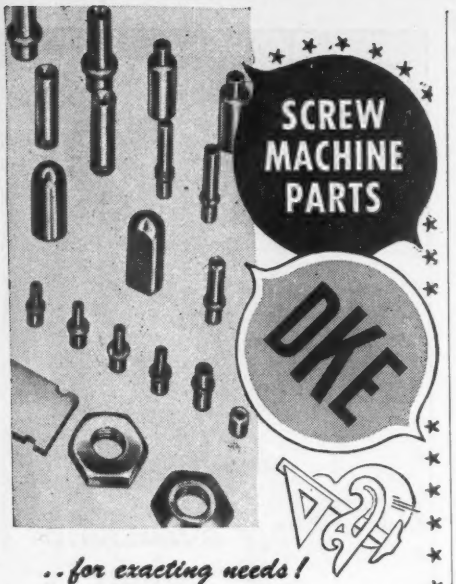

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depending on primary overload relays. As a result, the damage to the good tubes is minimized and the chances of successful immediate restoration of power are substantially improved.

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RCA International Adds Boonton For Export

Boonton Radio Corp., Boonton N. J., has completed an arrangement with RCA International Division, under which distribution of Boonton products outside of the United States is to be taken over by RCA. Boonton designs and manufactures a Q-meter, a QX-checker, signal generators, and other direct reading instruments for the radio and electronic industries.

Insuline In Canada

In line with its expanding activities in the radio-electronic field Insuline Corp. of America, Long Island City, N. Y., has opened a branch plant in Canada. Known as the Insuline Corp. of America (Canada) Ltd., the new plant will be located at 9500 St. Lawrence Ave., Montreal. Coincident with the opening of the new branch Sni-Dor Radioelectric, Ltd., has been appointed exclusive ICA sales representatives for all Canadian territory. Headquarters are in Montreal.

Sangamo Adds Capacitors To Canadian Output

The Canadian affiliate of the Sangamo Electric Co., Springfield Ill., which does business as the Sangamo Company, Ltd., Leaside, Ontario, has started the manufacture of mica and paper capacitors. Previously the Canadian company has confined its manufacturing activities to the production of meters and motors.

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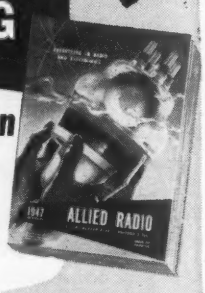

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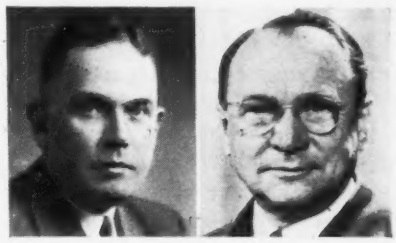
PERSONNEL

Dr. Vladimir Kosma Zworykin has been elected vice-president and technical consultant of the RCA Laboratories Division, Radio Corporation of America. Dr. Zworykin, who has been director of the electronic Research Laboratory of the RCA Laboratories Division, has received international recognition for his achievements in radio, television and electronics. He has been associated with RCA for 17 years.



C. W. Dalzell Dr. Zworykin

C. W. Dalzell, West Caldwell, N. J., has been appointed chief engineer of the Franklin Transformer Mfg. Co., Minneapolis. Formerly manager of engineering at Heyer Industries, Inc., Belleville, N. J., he served that company for twelve years before joining the staff of Franklin Transformer. He was also with Union Switch and Signal Co., Swissvale, Pa., and with Westinghouse Electric Corp. at East Pittsburgh.

Lt. Com. William J. Rooke (USNR) has been appointed head of a newly organized service department of the Hammerlund Mfg Co., New York.

Major General Spencer B. Akin has been appointed chief signal officer of the US Army. He succeeds Major General H. C. Ingles who filled the post since July 1943.

Dr. George H. Harrison, Dean of the school of science, MIT, has been elected chairman of the American Institute of Science. He succeeds Dr. Paul E. Klopsteg.

Admiral William F. Halsey, Jr., who has recently completed an outstanding naval career, has been elected to the board of directors of the International Telephone and Telegraph Corp., N. Y.

Clyde E. Dickey has been appointed general sales director of

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Federal Telephone and Telegraph Corp. Dickey, who has been associated with IT&T for more than 19 years, will be in direct charge of sales of commercial radios, rectifiers, Megatherm, wire transmission, equipment, rectifier stacks, wire and cable, tubes, transformers, crystals and air lines.

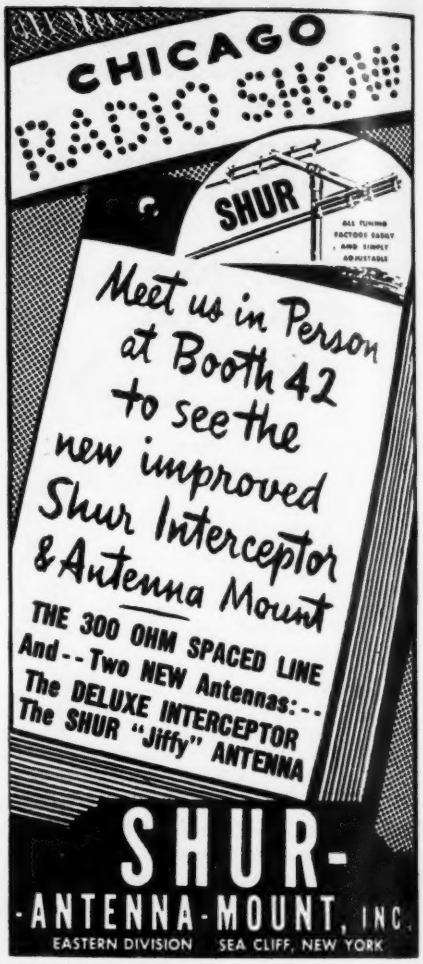
Culminating a continuous government career extending back through the past 24 years, **George E. Sterling** has been appointed chief engineer of the Federal Communications Commission. Sterling joined the Commerce Department's Bureau of Navigation as a radio inspector in 1923. From there he went to the Federal Radio Commission and then into the engineering department of its successor agency, the FCC, first in the field as inspector-in-charge and since June, 1937, in Washington. Sterling takes the place of **George P. Adair** who resigned as Chief Engineer of FCC on March 21. Adair had been continuously connected with FCC since 1931.

G. E. Sterling Dr. P. J. Selgin

Dr. P. J. Selgin, expert in high frequency radiation and electronics. has been appointed to the staff of the National Bureau of Standards. He will work on the development of electronic ordnance for the military services in the ordnance development division. This division, established late in 1942, serves as a research and development agency for the armed services in electronics ordnance, and is the central unit within the Bureau of Standards in the field of applied electronics.

Concord Adds Store

Supplementing its headquarters store at 901 W. Jackson Blvd.. Concord Radio on March 17 opened its second establishment in the heart of Chicago's central business district. The new store, especially designed and stocked to facilitate serving the electronics industries is located at 229 W. Madison St.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New Plastic Screen for RCA Projection TV

A new screen for its projection television receivers has been developed by Radio Corp. of America. It is designed to give considerably greater brightness and to permit pictures which compare in brilliance with those produced by direct-view tubes. The new screen, approximately 15 x 20 inches, is based on a new plastic development and is to be used in RCA projection models scheduled to reach the market this year. The screen was demonstrated before a joint meeting of the IRE and AIEE in New York early in April.

Sells Chicago Plant

Allied Control Co. Inc., New York, manufacturer of relays, has sold its Chicago plant to the General Transformer Co. and the equipment and personal property to S. L. Winternitz & Co. All Allied Relays will now be manufactured at its old established plant at Plantsville, Conn. All sales will be handled from its present general sales offices in New York city.

Raytheon Moves Broadcast Division To Chicago

In order to facilitate larger production, Raytheon Mfg. Co., is preparing to move its broadcast equipment division, to its main plant in Waltham, Mass. At present the company's broadcast equipment is manufactured in its Chicaga plant.

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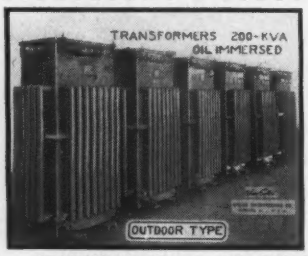

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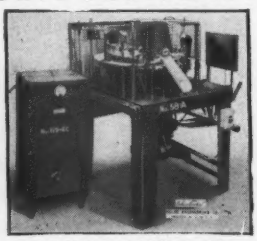

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